THE KINGSWAY SERIES

NATURE STUDY AND THE BLACKBOARD

VOLUME ONE

By F. H. SHOOSMITH, Ph.D., B.Sc. (Lond.).

EVANS BROS. LONDON

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VOLUME ONE

LONDON
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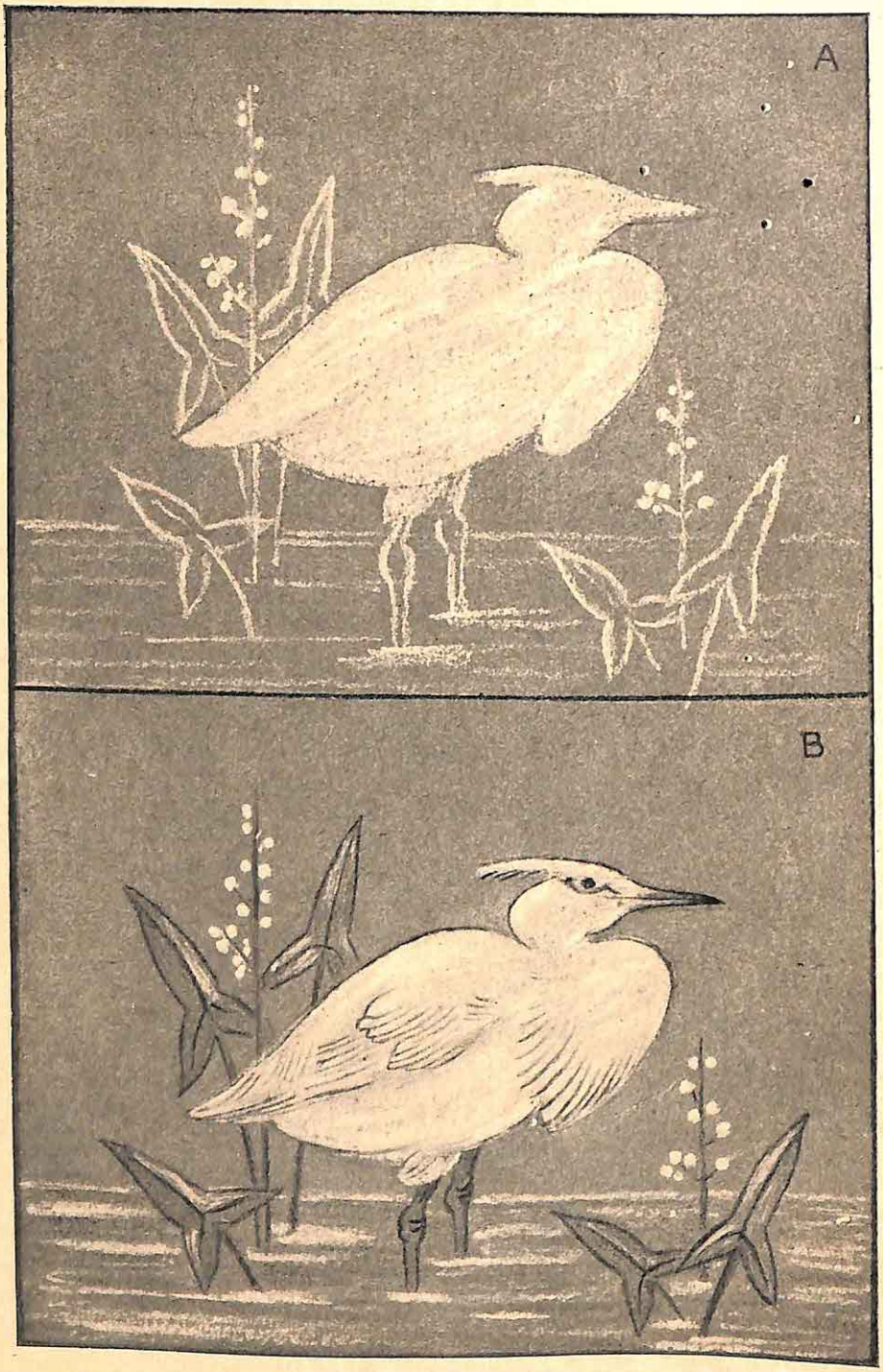

A
B

INTRODUCTION

SINCE this book, both in respect of the drawings and the notes, has been prepared as an aid to Nature Study, and not in any sense as a substitute for it, it is sincerely hoped that it will be used as intended and thereby find its justification. Thus, in the majority of cases, the drawings are not intended to be copied on the blackboard; but rather it is suggested that they are such as can be drawn with chalk from the actual objects, what time those objects are under observation. The original intention was to make them as simple as possible—bare outlines only—and to claim for them that they were of such a nature that any one could produce similar sketches "without possessing any but a rudimentary knowledge and aptitude for drawing." In many cases, however, something more than a mere outline has been given, because such drawings are more effective and pleasing, without being really more difficult to produce.

The Main Object of Blackboard Drawing

It may be conceded that any drawing direct from Nature demands some amount of effort as well as skill and practice; but it is not necessary to be an expert with chalk to make sketches which are really effective and of distinct value. For it is contended that a blackboard drawing to be of value need be neither accurate nor complete, its main object being to direct attention to certain features of the object under observation, and so long as it is thus directive it is of value, however crude and imperfect it may be.

Degrees of Accuracy Essential

Nevertheless, it must be insisted upon that there are various grades or species of inaccuracy, some of which, being harmless, may be justified; while others are harmful and cannot be justified. Thus, while it is permissible to draw an insect's legs inaccurately as regards their minor details, it is not permissible to represent them as growing from the head or from the abdomen—legs as well as wings always being attached to the chest or thorax. Again, while the accurate drawing, say, of a primrose leaf is of comparatively little importance,

it is of essential importance that it should be represented as being practically devoid of a stalk, and as gradually widening from the base towards the tip, this shape being correlated with the rosette arrangement of the leaves on a compressed stem, in contrast with such leaves as those of the Nettle, which, being arranged in pairs at intervals on a tall vertical stem, have their broadest part near the base.

How Detail is to be Treated

And, similarly, as regards completeness. Indeed, in many cases it is not only justifiable but wise to omit details from a drawing both for the sake of clearness and of emphasis, the omission of parts, for example, being particularly permissible where there is considerable repetition of such parts. Much depends on the purpose for which the drawing is being made, and on the time that can be spared for the making of the drawing. Thus nothing is gained when making a sketch of a leaf mosaic by putting in details of the venation, and of the serration of the edges, of each leaf, since these features are not being studied ; nor by drawing the details of each leg of an insect or of a crustacean when these details are not under observation.

The Need for a Good Standard of Work

But while from such points of view incompleteness and inaccuracy of a kind are justifiable, poor work, due to defective observation, carelessness or slackness, is certainly not, its effect being wholly harmful. It is therefore assumed that when blackboard sketches are made they will be commensurate with the " knowledge, skill and aptitude " of the teacher, both for the credit of the teacher and the encouragement of the child to " do likewise " or even better.

Details Beyond Direct Observation

Quite a number of things worth knowing are beyond the direct observation of the average student, and more especially of each individual child in a large class ; and in such cases drawings are of especial value. Moreover, it is such drawings which may be fairly

copied from such sources as are available without incurring the charge of substituting illustrations for actual objects. Such are details of the skeleton, and the internal organs of animals; of the tissues of plants, and so on; and of such drawings a considerable number will be found in the following Plates.

The Drawings

And having said so much the author is moved to make confession with the author of *The Artistic Anatomy of Trees*, but with vastly more cause, that it is not because "I think I can draw (things) really well, but only because I know that a large number of people draw them worse," that the illustrations have been prepared. And, further, it may be explained that, owing to various causes, the preparation of the drawings has been spread over a much longer period than had been intended, and that this has involved the use of materials of varying nature and quality—both facts partly accounting for the obvious variations in the nature of the drawings. Nevertheless, the author dares to hope that in some cases at least, the illustrations are such as to suggest that chalk drawings can be made artistic as well as instructive; and the blessed word "correlation" once again find its application. It is partly for this reason that something more than bare outlines has been given in many cases.

How to Fill in the Outlines

Very little skill is needed in filling in the outlines, a flat tint being put in by using the chalk lengthwise instead of the point. In such cases as the wing of a Butterfly, where dark spots or veins (*nervures*) appear on an otherwise uniformly-tinted ground, it is easier to fill in the entire wing with the tint, and then to pick out the spots or veins with a damp point, *e.g.*, a damp duster on the finger-tip, or a piece of pointed wood. And, similarly with the stamens of white flowers, veins in leaves, etc., etc. As an example of this method the illustration on page viii will serve. A is a stage in the making of a drawing in white only. B is the same bird picked out as suggested; and in addition black is used in accordance with the following paragraph.

Coloured Chalk Drawings on Tinted Paper

More effective still are drawings made on tinted paper with chalk of various colours, the simplest being black and white on a tinted background ; although a combination of colours is as easy to employ as one only. Coloured chalks can be readily obtained ; or they can be made by thoroughing soaking white chalk in inks of various colours. These can be used on the blackboard or on tinted paper ; and in the latter case the work can be rendered permanent by being sprayed with fixative, obtained together with instructions from any artists' colourman. (The Frontispiece was drawn on the cover of a trade catalogue with black and white chalks, and greatly improved by a reddish tint being given to the anthers, young leaves and stems, faintly or strongly according to requirements.) Such permanent records are of value for revision purposes, as well as for decorative purposes.

The Notes on the Drawings

Being limited to a page facing the drawings, the notes accompanying them cannot possibly do more than deal briefly with a few of the salient points of the subject studied. Always in Nature Study, where the scope is so wide and the details so numerous, selection is necessary ; and one of the teacher's most valuable gifts is that of being able to make the right selection. The art of omission has a value greater than is commonly recognised. It has been contended that it matters little what is taught so long as it is taught well ; but the contention is not only indefensible, but simply deplorable in its tendencies. It would be easier to defend the contrary, that it matters little how the subject is taught so long as it is worth teaching ; although, of course, both subject-matter and method are of the greatest importance. It is hoped, therefore, that nothing futile, or insignificant, or uninteresting, will be found in the notes ; although, such as they are, they are wofully incomplete, and have reference to little but what is illustrated by the sketches.

The Purpose of Nature Study

They have been written in the belief that they indicate the kind of knowledge that is calculated to develop in the student of any age

whatever capacity within him lies of becoming a Nature Lover. And it is earnestly urged that *it is with the development of Nature Lovers that the teacher* of the subject *is primarily concerned.* The actual selection of subjects to be studied must vary widely in accordance with the environment ; and in many cases there may well be a bias towards the economic or utilitarian aspect of the subject. Nevertheless, always and everywhere, it is the development of a living, permanent interest in Nature for which the teacher should earnestly strive. Nature Study is a subject of so wide and varied a range that it never stales or grows unprofitable ; and it gives an interest in the world in which we live greater than any other. And further, without claiming any particular moral value for the study—although something might be urged in that respect—it is declared by the most eminent authorities that *of all influences that tend to steady and calm the mind and keep it sane* under the stress of modern life *the love of Nature is unrivalled.* That alone would justify, and should secure, the inclusion of the subject in the curriculum of every school in the land, not to be dealt with grudgingly and regarded as an extraneous subject ; but to be regarded as something that makes for the happiness of mankind, and be dealt with accordingly.

The Great Aim of School Nature Study

It is not a knowledge of technical details that makes the Nature Lover, although such knowledge is not to be despised and, indeed, in its proper place, has its value. The great aim of school Nature Study should be the sympathetic observation and study of natural phenomena and of living things ; of the way in which the animal or plant lives and has its being ; of its needs and how they are supplied ; of the danger to which it is exposed and how they are avoided or overcome ; of the significance of such obvious features as shape and colour ; of its environment and its adaptation thereto ; and so on.

Mistaken Simplification

In the pursuit of this aim the deplorable mistake should not be made of dealing with the subject as though, in order to render it

interesting, it must be shorn of all difficulties ; that all technicalities, including the correct names of things, must be avoided ; and that, in brief, the learner must be " spoon fed." *That way lies failure.* The average child delights in the acquisition—within bounds—of " hard words " ; it gives him a " grown-up feeling." The " sting " should no more be taken out of Nature Study than of any other subject ; and it is as grossly unjust to the children to do so, as to think for them, or to do work which they are quite capable and even eager to do for themselves. Effortless work is comparatively valueless to them. There is no need to invent difficulties in order to overcome them ; any more than there is to use language difficult to understand where simple language serves all useful purposes. In which connection it may be remarked that that which cannot be taught truly owing to difficulty either of language or of idea should be among those things not selected : or if some acquaintance with the facts is necessary at any given stage it is better simply to state—or accept—the facts than to explain them incorrectly, or deal falsely with them in any way. It ought not to be necessary for any of us to have to " learn to unlearn what we have learned amiss."

Teach in the Context of Nature

Nor should anything in the nature of rhetoric or any attempt at eloquence be allowed to confuse thought, or give admittance to inaccuracies ; which is far too often the case when the " orator " has little or no first-hand knowledge of the subject. Indeed, only to Nature students can safely be entrusted the task of supervising Nature Study ; and hence it is that just as the drawings in this book are not intended to be copied when the actual objects are available, so the notes are not intended to be memorised : they should be *thought through*, rather than read through, with due reference to Nature itself. It is quite possible that not every statement made therein is above suspicion ; although it is hoped that they will, as a matter of fact, be found reliable, as well as stimulating and interesting. But even so that does not and cannot qualify the author to observe and think for those whose duty is to observe and think for themselves.

F. H. S.

Compare this drawing (in black and white on grey paper) for effectiveness with that in Lesson I.

I. THE SNOWDROP

THE Snowdrop owes its name to its gracefully drooping white blossom (Fig. 1). While in the bud (which is erect), the flower is enclosed in a sheath which, later, bursts along one side and sets the bud free. The slender flower-stalk then lengthens, the bud opens, and the flower becomes pendant, the nectar and the pollen being thereby protected from rain and cold. Further protection is afforded by the flower closing about sunset and remaining closed until the sun is well up next morning.

From the edge of the green seed-case (Fig. 2, section) spring three beautiful white floral leaves (sepals), and within these three smaller leaves (petals) notched at the edge and decorated with a band of pure green. Within these stand the six stamens, with large yellow anthers, surrounding the long, slender style at the tip of which is the stigma upon which pollen must be placed if good seeds are to be formed. Bees visit the Snowdrop for the sweet nectar to be found in the grooves on the inner surface of the petals; and while doing this they carry away pollen from one flower and deposit it on the stigma of another.

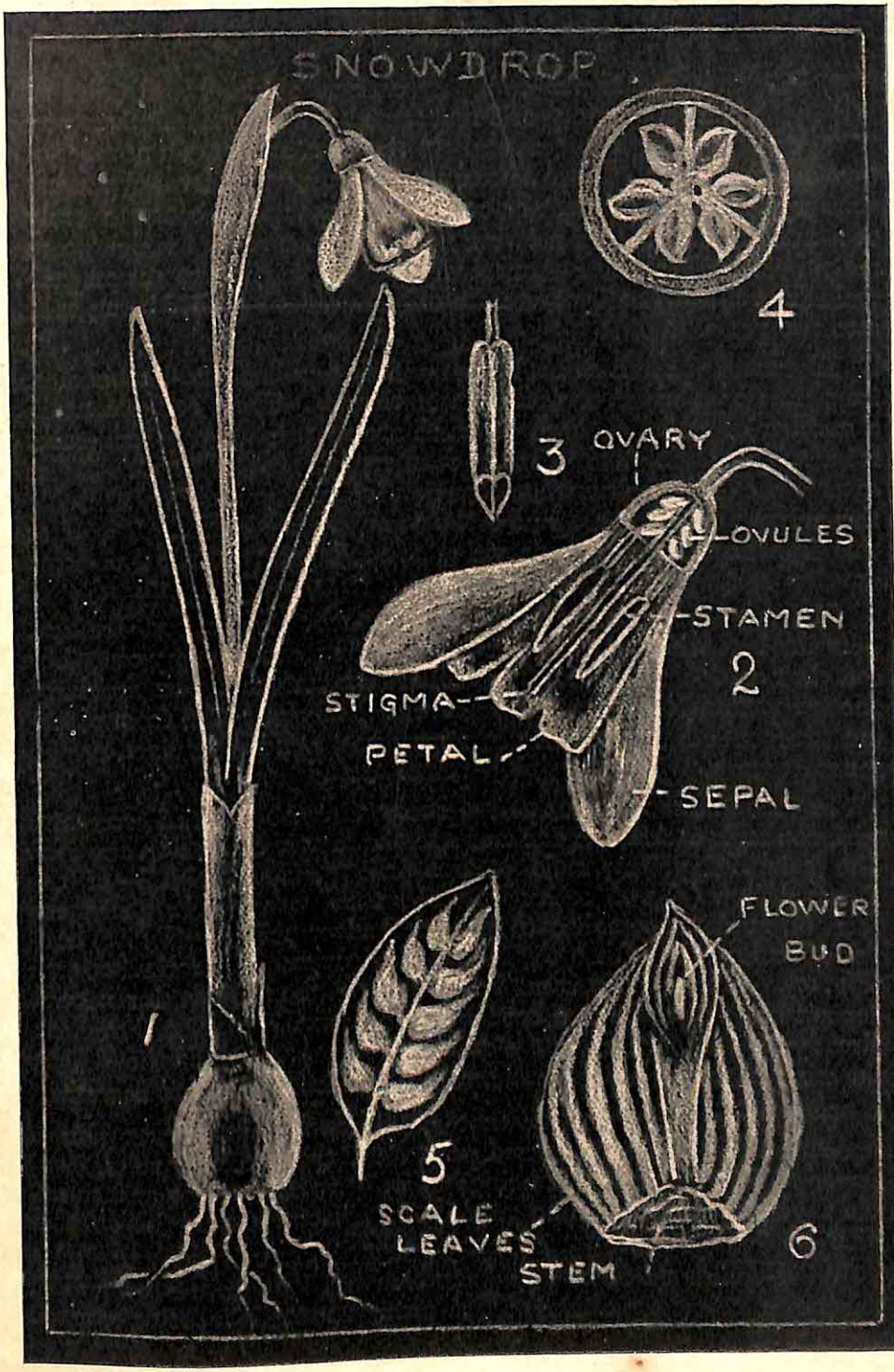
The ripe anthers (Fig. 3) open by slits to allow the pollen to escape, and their tips are drawn out into a kind of spur which curves towards the petals.

The green seed-case or ovary (Fig. 4, cross-section) consists of three parts (*carpels*) each of which contains a number of tiny white ovules. When ripe the seed-case splits into three parts, the central column also breaks up, and thus the ripened seeds are set free. (One lobe of the seed-case is shown in Fig. 5.)

The leaves are long and grass-like, and are enclosed by a common sheath for a considerable part of their length. The veins of the leaves run side by side from base to tip, as is the rule in plants which bear flowers with the sepals, petals and other parts in threes.

The bulb (Fig. 6) consists of a very short, flattened stem, from which spring a number of fleshy scale-leaves, which are store-houses of food upon which the flower-bud has to live. This food-store was laid up by the green leaves of the preceding year. The juice of the bulb is very bitter and unpleasant to taste, and this protects it from attack by gnawing underground creatures. Between the scales may be found one or more buds, and these grow into new bulbs from which fresh plants arise quite apart from seeds.

From the edges of the flattened stem spring the fibrous roots (Fig. 1) whose work is to absorb moisture and other raw food-stuffs from the soil.


SNOWDROP
4
3
OVARY
OVULES
STAMEN
2
STIGMA
PETAL
SEPAL
1
5
SCALE LEAVES
FLOWER BUD
STEM
6

II. CATKINS

THE familiar "lambs'-tails" or catkins of the Hazel (Fig. 1), which, after standing stiff and straight for several months, sway gracefully in the breeze early in the year, consist of a number of tiny, simple flowers. These flowers are very imperfect, for they possess neither sepals nor petals, nor even seed-cases; they consist merely of a number of stamens growing upon scales, many of which go to make up a single catkin. Apparently there are eight stamens on each scale (Fig. 2), but really there are only four, each anther being split into two parts.

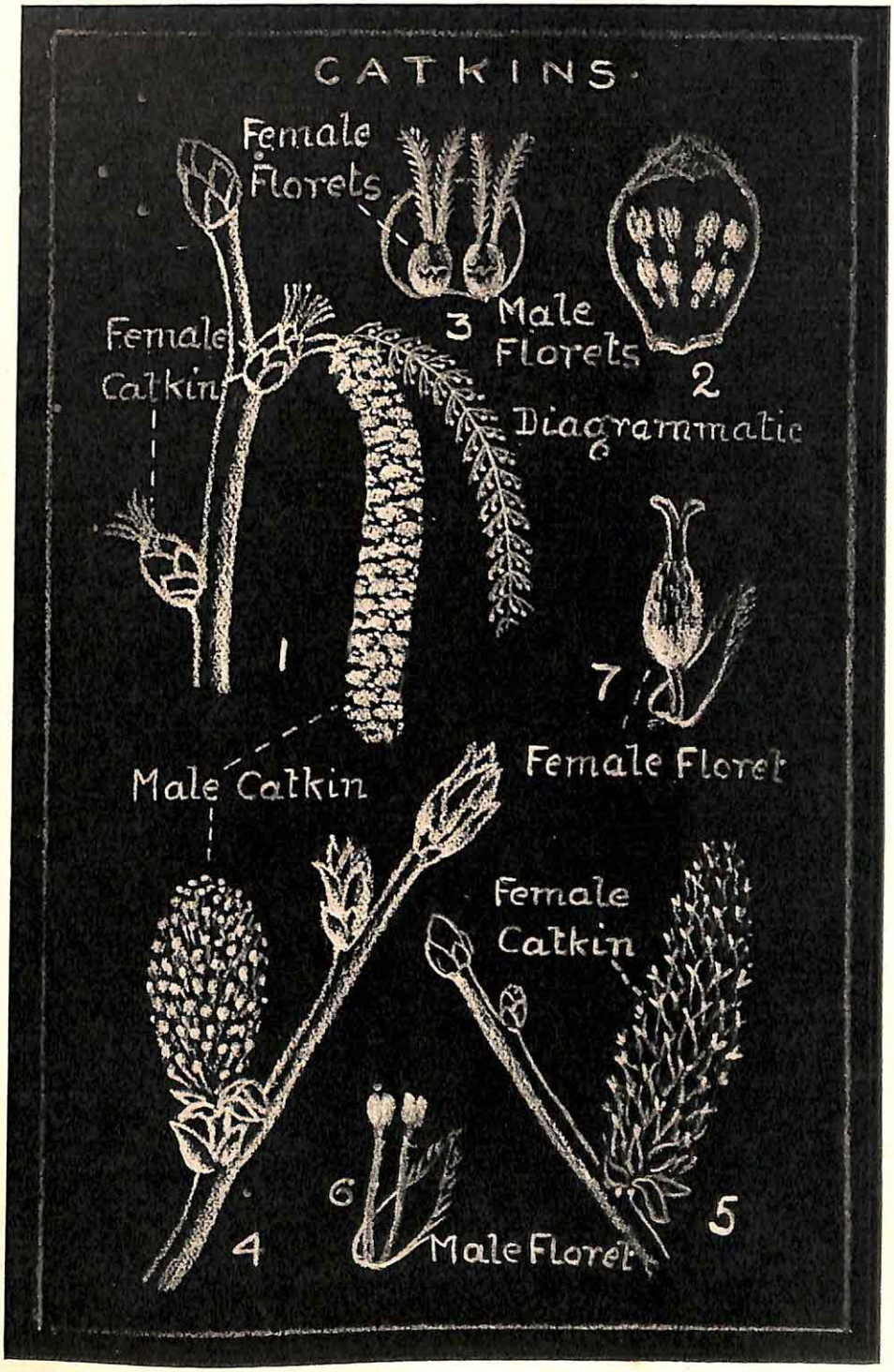
Elsewhere on the same bush are less familiar bud-like bodies, from the tips of which project crimson threads. These bodies contain a number of scales, on each of which are seated two tiny seed-cases from which spring the crimson feathery threads (Fig. 3). These catch some of the pollen when that powdery yellow dust is sent flying through the air when the ripe catkins sway in the breeze. It is after this that the crimson threads wither and fall, and the little seed-cases develop into nuts.

Many other trees and bushes, *e.g.*, Birch, Poplar, and Walnut, bear similar catkins of male or pollen flowers; and in every case they set their pollen free before the foliage leaves appear or are large enough to stand in the way and prevent the flying pollen from reaching the female flowers, which in some cases, *e.g.*, the Poplars, are on separate trees.

In the Willow the catkins are not pendent, but stand erect and stiff, the male catkins on one tree and the female catkins on another. The beautiful yellow male catkins—the "golden palm"—of the Pussy Willow (Fig. 4) consist of scales each with two long stamens (Fig. 6), while the female catkins—the "silver palm"—(Fig. 5) consist of scales each with a single seed-case topped by a forked stigma (Fig. 7). Upon the stigma bees, visiting the Willow for nectar, deposit some of the pollen brought from the male catkins they have already visited; although it is quite possible that even in the Willow the wind plays some part in carrying pollen from flower to flower.

It is interesting to note that wind-borne pollen is very light, smooth, and dry as compared with that carried by insects from flower to flower; the latter being larger, heavier, rougher and somewhat viscid so as to cling readily to insects coming in contact with it.

Wind-pollinated flowers also produce large quantities of pollen, this being necessary owing to the greater part of it being wasted and lost.


CATKINS
Female Florets
3
Male Florets
2
Female Catkin
Diagrammatic
1
7
Female Floret
Male Catkin
Female Catkin
6
4
Male Floret
5

III. THE LESSER CELANDINE

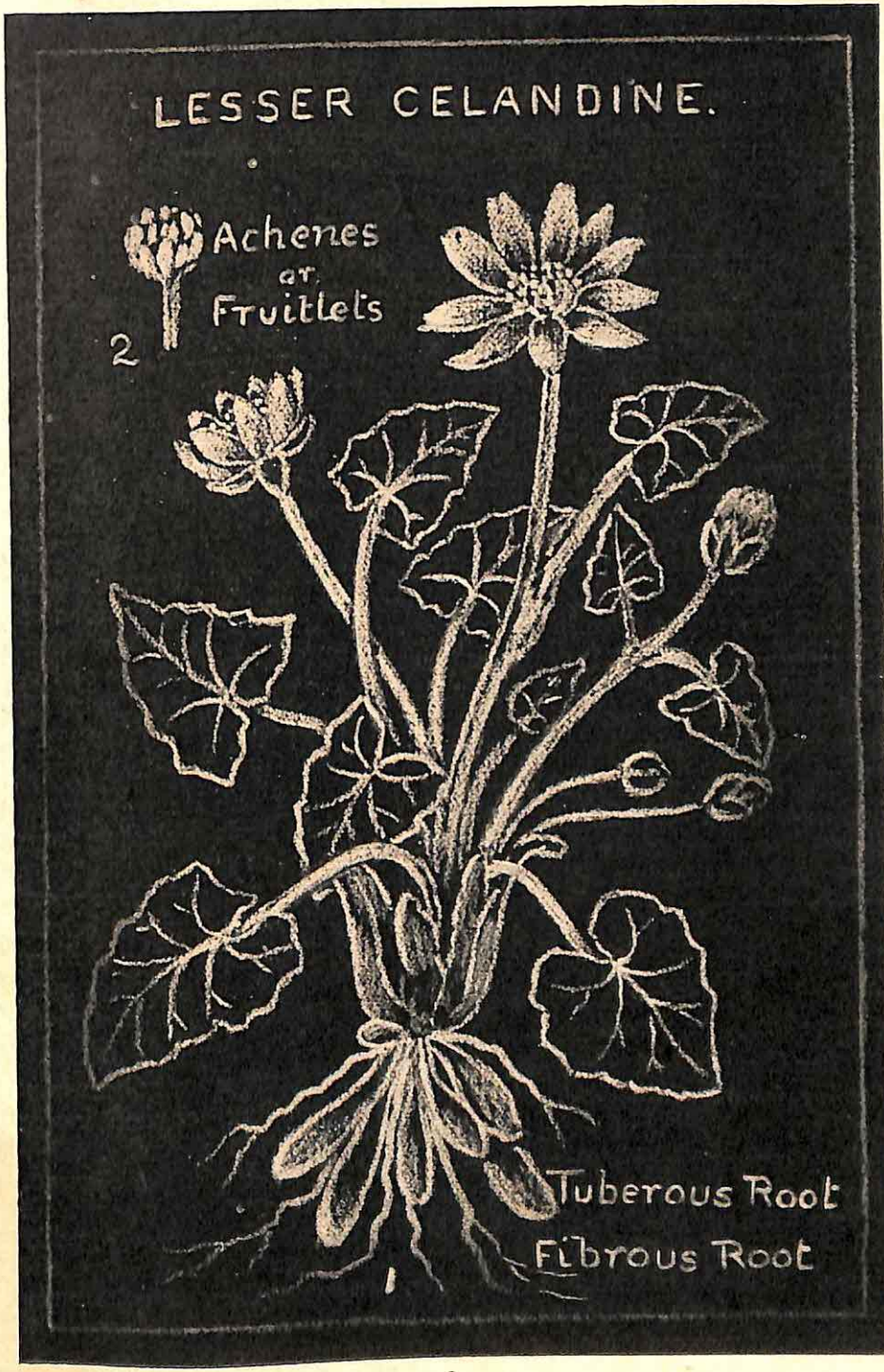
THE Lesser Celandine has been well described as "the first gilt thing of Spring." It is not a true Celandine for it belongs to the great Buttercup Family, whereas the true Celandine—the Greater Celandine—is a member of the Poppy Family. The word "Celandine" means "swallow flower"; but the glossy star-like flowers of the Lesser Celandine appear long before the swallow returns to us from warmer lands, blooming as early as February, although March and April see the golden blossoms at their best.

The glossy golden inner or upper surface of the petals facing the sky contrasts strongly with the duller and darker outside or under surface which is turned earthwards when the flower is wide open. Such a contrast is common in flowers that face the open sky, whereas in pendent blossoms the outer surface is more brilliantly coloured than the inner. Such glossy yellow blossoms can scarcely be overlooked by bees and other insects a-wing in search of nectar or pollen, both of which are provided by the Lesser Celandine—pollen by the numerous stamens, and nectar by the scale-like nectaries at the base of the petals. Both are protected from dampness and cold by the flowers closing at night and during dull weather.

At first the stamens curl inwards, but as they ripen, beginning at the outer ring and progressing inwards, they turn outwards, leaving the seed-cases in the middle of the flower free to be powdered with pollen. Strangely enough, the Lesser Celandine forms but few good seeds, young plants being more often produced by quite other means. What seeds are formed are contained separately in little dry fruitlets or *achenes* (Fig. 2).

The foliage leaves are smooth, juicy and glossy, and are almost free from the bitter juices which protect the Lesser Celandine's buttercup relatives from browsing animals. But then, as a rule, the Lesser Celandine does not grow in meadows or other places where grazing animals are wont to roam.

There are two kinds of roots (Fig. 1)—fine, fibrous roots, and thick, fleshy tuberous roots. The latter form store-houses of food which enable the plant to live from year to year, sending up fresh leaves and flowers when the winter is over. The tuberous roots also break away from the parent plant, each bearing a small bud from which a new plant may arise. The Lesser Celandine has still another means of forming new plants, viz., by little *tubers* or *bulbils* which are produced in the axils of the green leaves, especially when the plant grows in a very shady place.


LESSER CELANDINE.
Achenes
or
Fruitlets
2
Tuberous Root
Fibrous Root

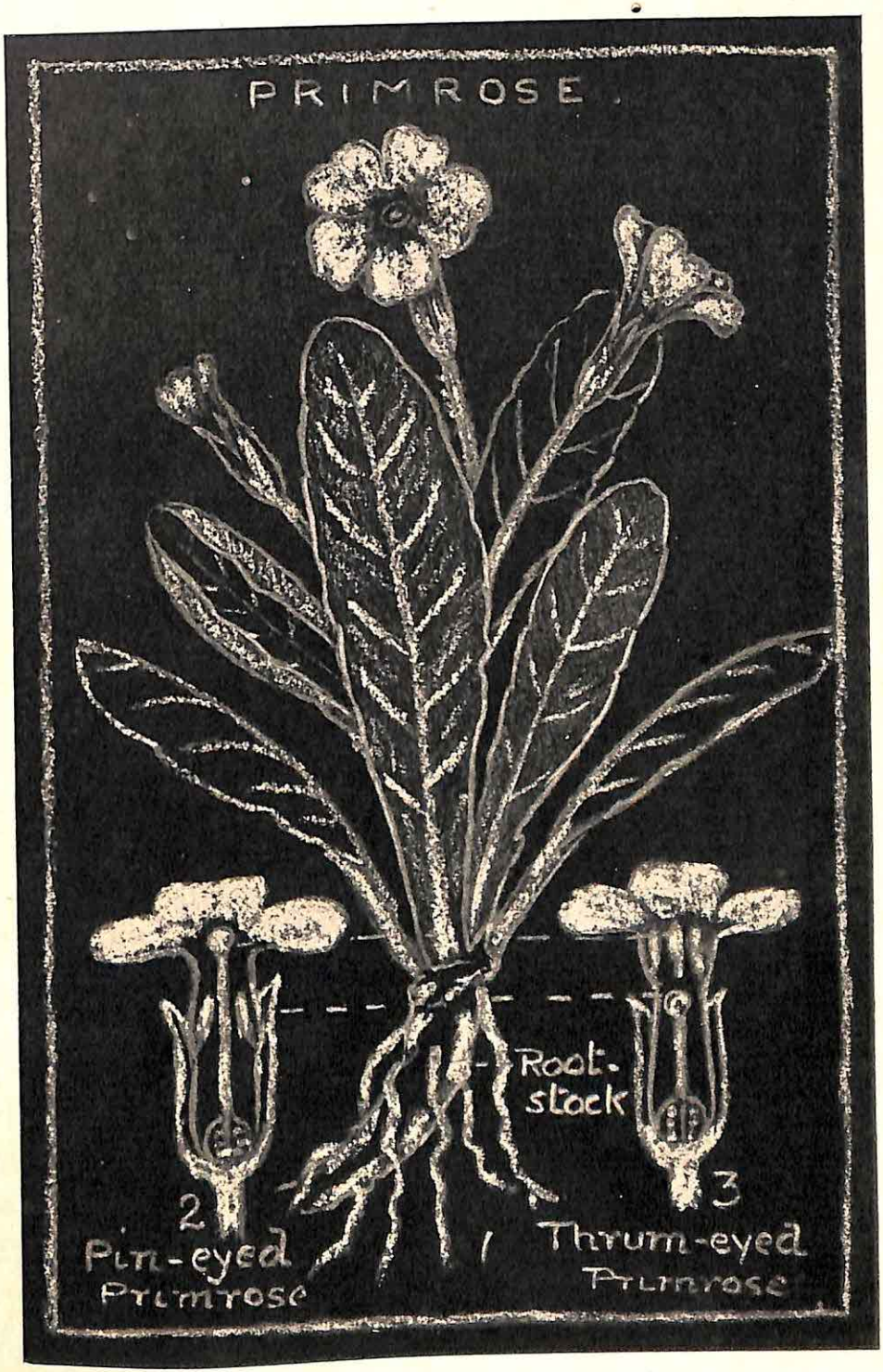
IV. THE PRIMROSE

IN some parts of the Continent the Primrose is called the Key-Flower, because "it unlocks the Spring." It is not a *rose* of any kind, the name really meaning "the little early one." It is able to bloom early in the year because of the food-stores laid up by the green leaves in the fleshy, underground stem (root-stock or rhizome) (Fig. 1), by means of which the plant is able to live on from one year to another.

From this root-stock spring the rootlets, some of which will be found to be wrinkled. These wrinkles are due to the fact that the rootlets shortened or contracted after they had taken a firm hold on the soil by their root-hairs; and by thus shortening they dragged the root-stock downwards. It is due to this *root-pull* that the root-stock is unable to grow upwards into the light as it otherwise would do; and thus the leaves always spring from the end of the root-stock just below the surface of the ground. The foliage leaves form a kind of loose rosette, their shape, narrow at the base and broadening towards the tip, being well suited to such an arrangement, by shading each other as little as possible. The rosette arrangement of leaves is of advantage to a plant, inasmuch as it tends to cover an area of ground large enough to supply its needs, overshadowing any other plant that attempts to crowd too closely to it. The surface of the leaves is wrinkled and waxy, so that water falling on them runs off "like water off a duck's back," and, flowing downwards along the numerous channels, finds its way to the rootlets below.

The flowers are of two forms, of which only one form grows on any one plant. In the one (Fig. 2, section) the style springing from the seed-case or ovary is so long that its rounded tip stands in the mouth of the flower-tube like the head of a pin; while the five short stamens grow out of the wall of the flower-tube some distance below. In the other form (Fig. 3) the positions of the stigma and the anthers are reversed. Hence the one form is said to be long-styled, pin-centred, or pin-eyed; while the other is said to be short-styled, rose-centred, or thrum-eyed.

The Cowslip and other members of the Primrose Family bear two similar forms of blossom; and in each case long-tongued insect visitors, probing for honey, found at the bottom of the tube, carry pollen on their heads from the rose-centred flowers to the pin-centred, and on their long tongues from the pin-centred to the rose-centred. It is also possible that tiny winged creatures, able to crawl bodily down the narrow flower-tube, carry pollen from either form to the other. Still the primrose is able to use its own pollen, especially the rose-centred form, and can thus produce good seeds without any help from insect visitors which are by no means numerous.


PRIMROSE.
Root-stock
2
Pin-eyed Primrose
1
3
Thrum-eyed Primrose

V. THE DAFFODIL

DAFFODILS

"Come before the swallow dares and take
The winds of March with beauty."

But the beauty of the blossoms must not make us forget that the juices of the plant and of its relative the Narcissus are rather poisonous. Indeed, the name *Narcissus* comes from a Greek word meaning *torpor*, or *numbness*, such as is caused by certain poisons.

The Daffodil is sometimes called the Lent Lily; but really it is not a Lily, if only because no true Lily possesses a *corona* or crown (Fig. 2, C), which in the Daffodil forms the trumpet-shaped part of the flower standing within the six flower leaves, or perianth (Fig. 2, P. *Note.*—In this figure the letters P and C should be reversed). From the walls of the perianth spring six stamens, in the midst of which stands the style, growing out from the green seed-case or ovary (O), and holding its expanded stigma quite clear of the anthers.

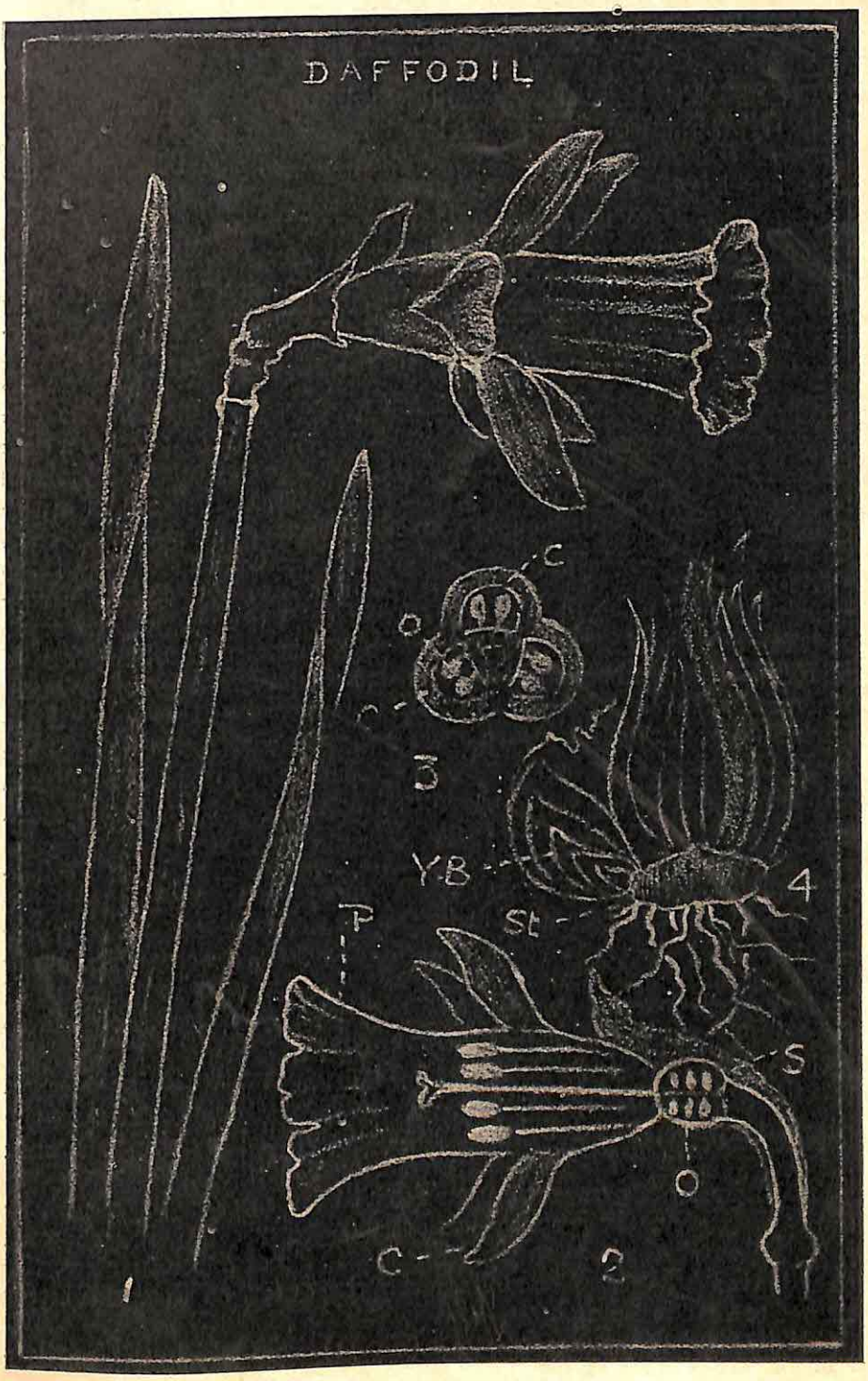
The flower bud is enclosed in a sheath which bursts to allow the flower to open, and remains as a brown crinkly sheath (Fig. 2, S), hiding the seed-case. The erect bud becomes the horizontal flower, in which position the pollen and the nectar are protected from cold and wet. Bees of various kinds, as well as flies and moths, visit the Daffodil for the nectar found in the lower part of the flower-tube; and in crawling in and out they are almost certain to carry pollen from the anthers of one flower to the stigma of the next flower visited.

The green seed-case, with its three chambers or carpels (Fig. 3, C = carpel, O = ovule), develops into a dry fruit or *capsule*. When ripe this splits open and sets free the smooth, black seeds.

New plants also arise quite apart from seeds. The bulb gives rise to one or more buds (Fig. 4, Y B) which may break free from the parent bulb after taking in as much food as is necessary to start it on a life of its own.

From the flattened stem (Fig. 4, St) spring the fibrous rootlets, similar to those of the Snowdrop.

The foliage leaves are long, narrow, and strap-shaped, and have their veins running side by side from base to tip, in accordance with the rule that such leaves accompany flowers with their parts in threes. The tips of the leaves are blunt and hard, enabling them to push their way upwards through the soil without getting bruised. The greyish waxy bloom with which the leaves are coated helps to keep them dry, and thus prevents water from stopping up the breathing pores; while the spiral twist (Fig. 1) helps to stiffen the long narrow leaves and enables them to stand erect as well as to sway safely in "the winds of March."


DAFFODIL
C
O
C
3
YB
4
P
St
S
O
C
2
1

VI. THE DAISY

THE Daisy is not strictly a flower, but rather a cluster or head (*capitulum*) of flowers, enclosed by a number of green *bracts*. In other words, it is a composite flower, and belongs to the great family called *Compositæ*.

In a daisy head (Fig. 2, section) there are two kind of florets, yellow florets (Fig. 3) with their five petals grown together into a tube, and white florets (Fig. 6) with their five petals grown together to form a strap with five points. The latter are called *ray florets*, and the yellow, *disc florets* from their position in the head. From the seed-case of the ray florets springs a style with a forked stigma, but there are no stamens; the florets are imperfect, whereas the disc florets are perfect, having five stamens as well as a seed-case (Fig. 4 shows a disc floret with the corolla opened). The five large anthers are joined together (Fig. 5) to form a tube, and it is because the anthers in the Scabious and some other composite flowers are quite free from each other that these flowers are not included in the Composite Family.

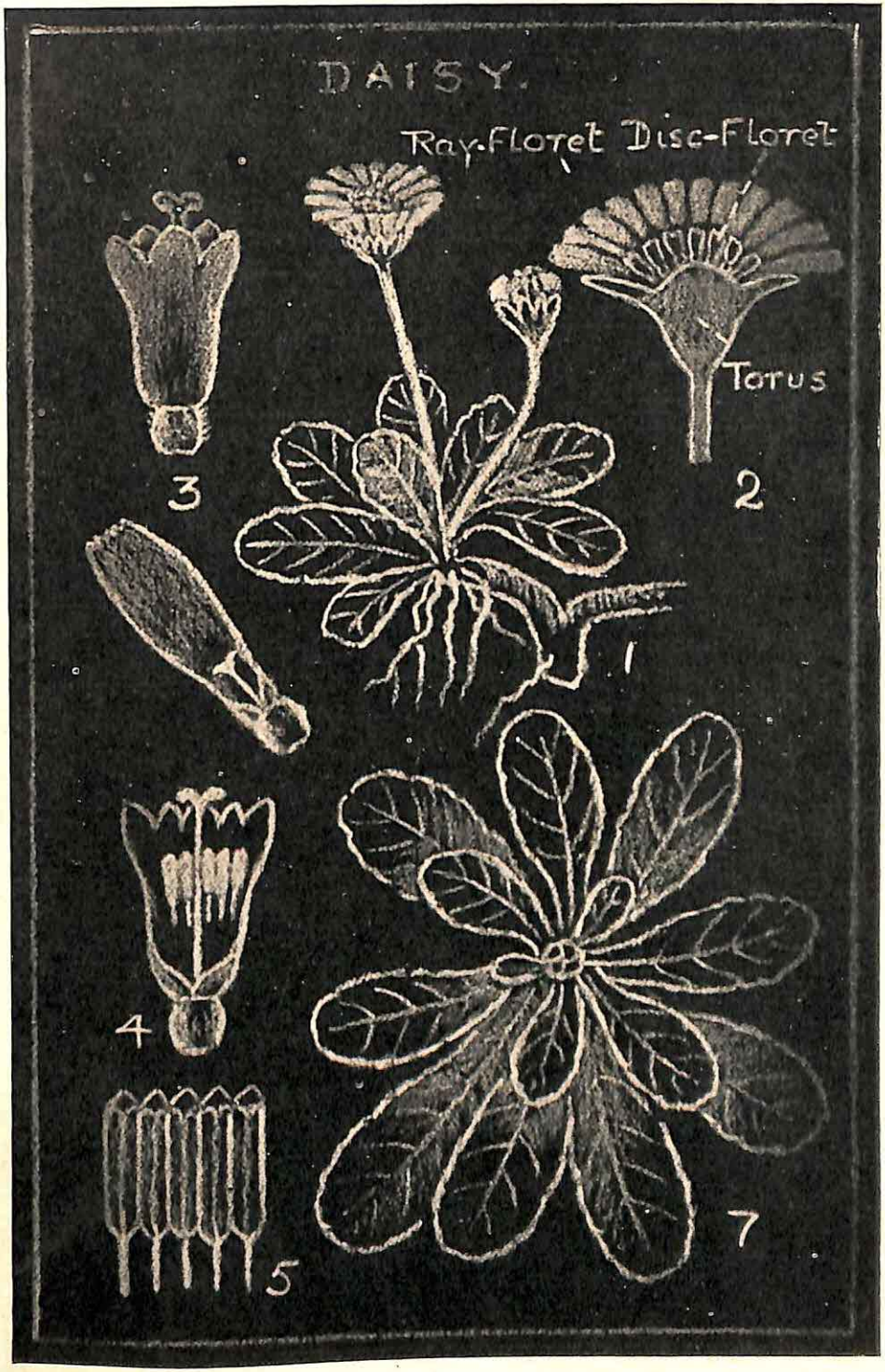
At first, the style in the disc florets is short, but when the ripe anthers have shed their pollen into the tube they form, the style lengthens, and pushing the pollen before it, piles it up at the mouth of the tube. It is the better able to do this because near the tip the style is covered with short hairs, so that it may be compared with a bottle-brush. (In the ray florets the style has no such hairs on it. There would be no work for them to do.) When the tip of the style has grown well beyond the mouth of the floret it splits, the two arms opening out and forming the stigma.

The disc florets do not all open at the same time, but from the outer edge inwards, so that in a given Daisy florets in all stages may be found, from unopened buds to those that have almost "set" their seed; and insects crawling about the disc are almost certain to carry pollen from floret to floret. But should this not happen the arms of the forked stigma curl over until they touch the hairs of the brush to which pollen grains are still clinging.

It is only during the day in fine weather that the Daisy is open. At night, and during dull weather, the white ray florets close over the yellow disc, and, aided by the green bracts, shelter it from harm; and this they do as long as such protection is needed.

The leaves are arranged in the form of a rosette (Fig. 7), and, as in the Primrose, their shape is adapted to such an arrangement, widening out from base to tip. They are also of different sizes, the inner leaves being much smaller than the outer, so that the latter are not too much shaded.

To its underground root-stock (Fig. 1) from which the rootlets spring, the Daisy owes its ability to live on from year to year.


DAISY.
Ray-Floret
Disc-Floret
Torus
1
2
3
4
5
7

VII. THE BUTTERCUP

THE name *Buttercup* is probably another form of *butter-cop*, *i.e.*, yellow-head (Old English *cop*=a head), although some will have it that it refers to the colour and shape of the flowers.

The first of the species to bloom is the Bulbous Buttercup (Fig. 1), this early blooming being connected with the food-stores laid up in the swollen base of the stem, this rounded mass not being a bulb, nor even a bulbous root. This food-store is not attacked by animals in search of food, for like the rest of the plant it is protected by its bitter juices.

The presence of this bulbous food-store may be told by a glance at the flower, the sepals of which are turned downwards, whereas those of the other buttercups are turned upwards close to the yellow petals.

The glossy inside of the flower cup is held skywards, open to all comers in the shape of flying insects, who find their reward in the sweet liquid poured out by the scale-like nectaries at the base of the petals (Fig. 3), or in the pollen produced by the numerous stamens. In the centre of the flower is a cluster of tiny seed-cases or *carpels* (Fig. 2), and these ripen into a rounded mass of dry fruitlets or *achenes* (Fig. 4), each containing a single seed (Fig. 6).

At first the stamens curl inwards, covering the young seed-cases; but as they ripen they curl outwards, and it is not until most of them have done this that the stigmas are free to receive pollen. Some of this is brought to them from other flowers by insect visitors, and some they get from the stamens of their own flowers.

The leaves of the Buttercup vary widely in form, not only in the different members of the family, but also on any given plant (Fig. 1), those lowest and highest on the stem being usually simpler than those between. In the Water Crowfoot the floating and submerged leaves are strikingly different (Fig. 5). The latter are very finely divided, a form which allows running water to pass freely and thus the leaves escape strain; while, as in the finely-divided gills of a fish, they are the better able to obtain what little air there is in the water to breathe.

So many of the members of the Buttercup Family, *e.g.*, the King-cup, grow in moist places, or actually in water, *e.g.*, the Water Crowfoot, that the rather curious name *Ranunculaceæ* has been given to it, *ranunculus* being the Latin word for "little frog."


BUTTERCUPS
Ovule
6
2
4
3
Nectary
1
5

VIII. THE VIOLET

THE Violet (Fig. 1), together with the Pansy, belongs to a plant family the flowers of which have a hollow spur (Fig. 2) containing the nectaries, the sweet juice from which is eagerly sought by bees and other long-tongued insects.

The foliage of the Violet is very different from that of the Pansy, a simple heart-shaped blade being borne on a long slender stalk. As in so many other plants the leaves increase both in size and number when the flowering season is over.

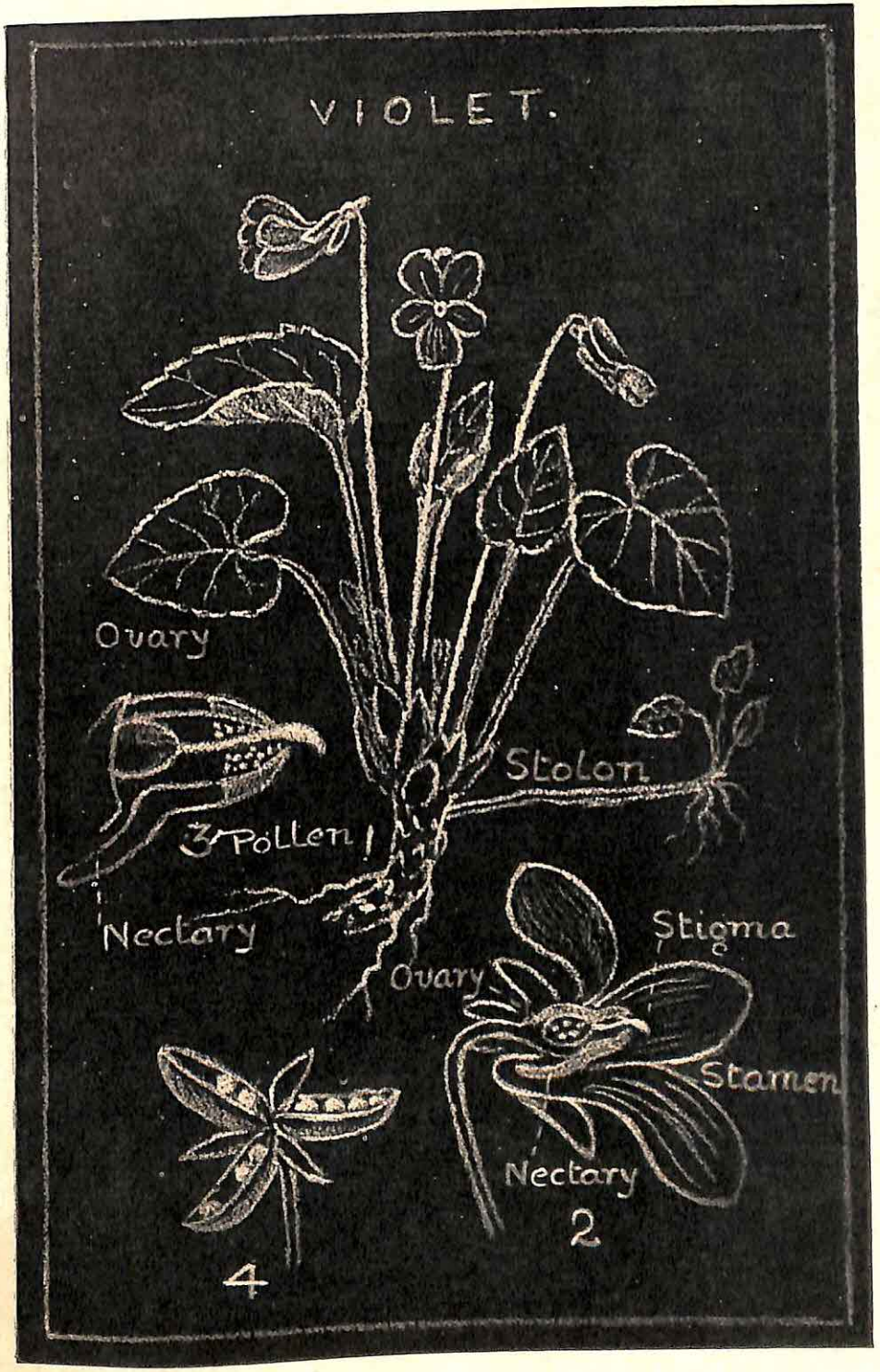
The leaves and flowers spring from a root-stock, which in the Sweet Violet (Fig. 1) gives off *runners* or *stolons* from which new plants arise. The Dog Violet has no such runners, depending entirely on its seeds to produce young plants. But, then, the pale flowers of the Dog Violet produce many more seeds than the darker, sweetly-scented flowers of the Sweet Violet, and scatter them further abroad.

The young flower bud is snugly enclosed by the two wings or *stipules* at the base of the foliage leaf, as well as by two green bracts on the flower stalk itself. When the bud is nearly ready to open the flower stalk lengthens until the two green bracts are half-way up; the upper part of the stalk curves over towards the light, and bends so as to bring the large spurred petal downwards, whereas its proper place is uppermost.

The five green sepals have each a little green flap, very seldom found in other flowers, and two of the five stamens send a little flat tail-piece down into the hollow spur of the large petal, where they secrete the nectar which rewards insect visitors (Fig. 2). Each of the five anthers has an orange-coloured flap, and these stand close together forming a tube into which they shed their pollen (Fig. 3). Through this tube passes the bent style, and when an insect visitor, probing for nectar, presses its head against the stigma, the style bends still more, forces open the anther-tube, when out falls some of the dusty pollen on the head of the insect which can scarcely fail to smear some of it on the stigma of the next flower visited.

Nevertheless the scented blossoms of the Sweet Violet form very few seeds—very many fewer than those of the Dog Violet, perhaps because it blooms earlier in the year. Still both species produce plenty of seeds by means of another kind of flower. These flowers have no petals, they never open, and they produce very little pollen, but what they do produce falls on the stigma so that none is wasted.

The ripe seed-case splits into three boat-shaped pieces called *valves* (Fig. 4), and in the Dog Violet, but not in the Sweet Violet, the smooth round seeds are shot away to some distance by the valves closing tightly on them, very much as an orange pip can be shot away by pressing it between the finger and the thumb.


VIOLET.
Ovary
Stolon
3 Pollen
Nectary
Stigma
Ovary
Stamen
Nectary
2
4

IX. GORSE

THE Gorse has been called a "plant hedgehog," because it is covered with sharp spines that render the plant very difficult to handle (Fig. 1). These spines are of two kinds, some, especially the larger ones, being short, pointed branches, while the rest are really leaves.

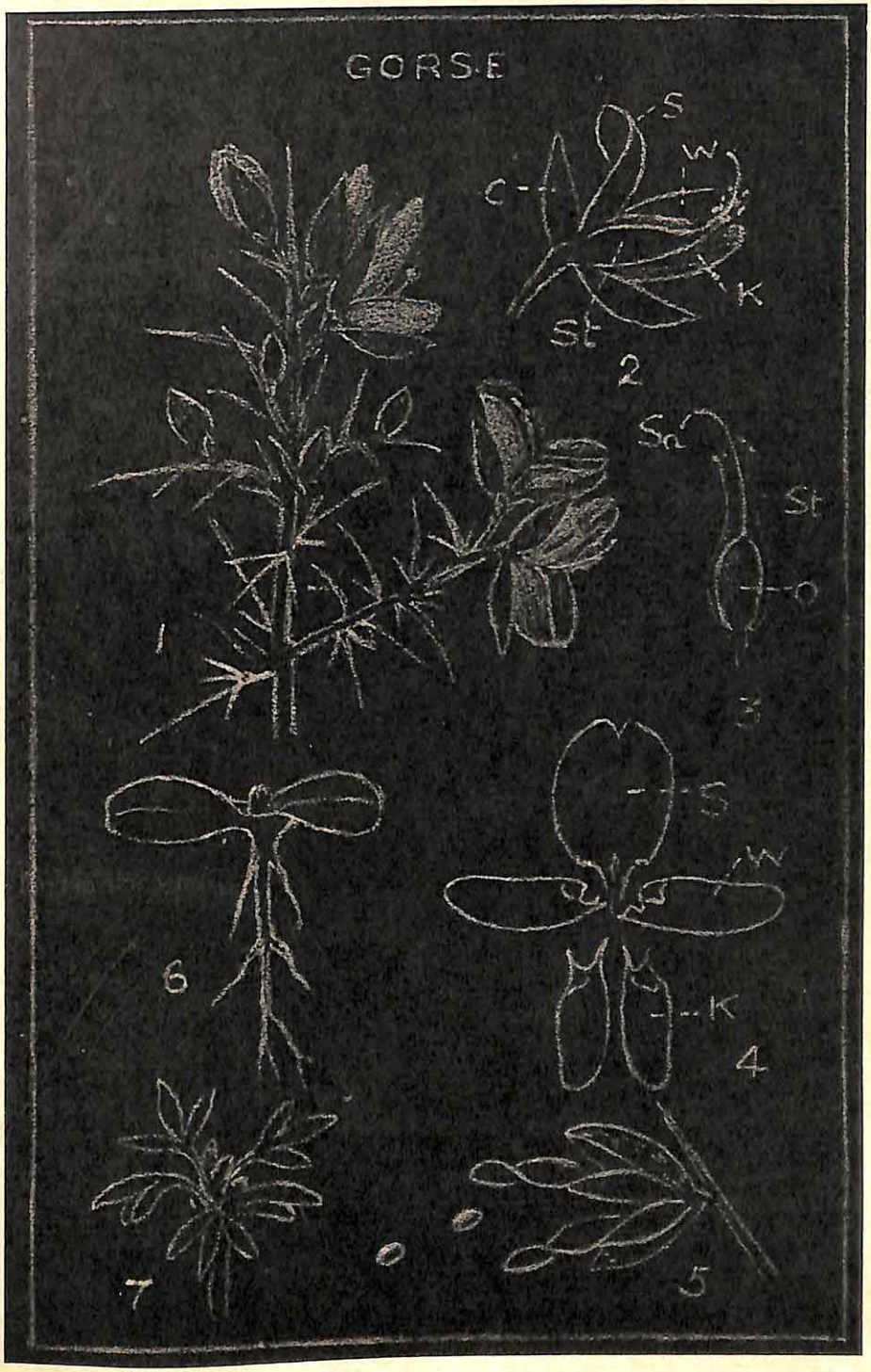
A young seedling gorse (Fig. 6) has first two green seed-leaves, and then sends out a number of soft, green foliage leaves with three leaflets (Fig. 7), reminding us of the leaflets of clover, which belongs to the same plant family as the Gorse. In its natural haunts, *e.g.*, dry hills and sandy commons, the young plant soon begins to produce spiny leaves and branches, but in moist situations that is not the case.

The value of such needle-shaped foliage is two-fold: its small surface and thick skin prevent the too rapid loss of moisture where moisture is scarce or where drying breezes are strong; and, secondly, such foliage discourages the attention of browsing animals, some of which, nevertheless, can manage to make a meal of it.

The flowers resemble those of the Sweet Pea, and of many other familiar plants, which have been somewhat fancifully called "butterfly flowers," and the plants "butterfly plants" (*Papilionaceæ*). The large upper petal (Figs. 2 and 4) is called the standard (S), the two side petals the wings (W), and the two lower petals the keel (K), the two last forming a boat-shaped covering to the seed-case and stamens (St).

For the greater part of their length the stamens grow together to form a tube enclosing the ovary (Fig. 3, O), *a sure sign that the flower contains no nectar*, for in those "butterfly flowers" which do contain nectar one of the stamens is free, leaving a slit in the tube through which an insect visitor can thrust its long tongue. Insects visit the Gorse for its pollen which is shed into the keel; and when the keel drops under the weight of an insect clinging to it, the pollen bursts forth in a little cloud and dusts the visitor, and some of it is probably smeared on to the projecting stigma (Fig. 3, Sa) of the next flower visited. The wing and keel petals (Fig. 4) have little projections on them near the base which interlock and hold the petals in position, until they are forced apart by the weight of an insect visitor.

The ovary develops into a pod or *legume* which when ripe bursts with a little explosive sound, and the two parts twisting suddenly into spirals (Fig. 5), jerk out the smooth hard seeds to some considerable distance from the parent bush.


GORSE
S
W
C
K
St
2
St
O
3
S
W
K
4
6
7
5

X. THE WILD ROSE

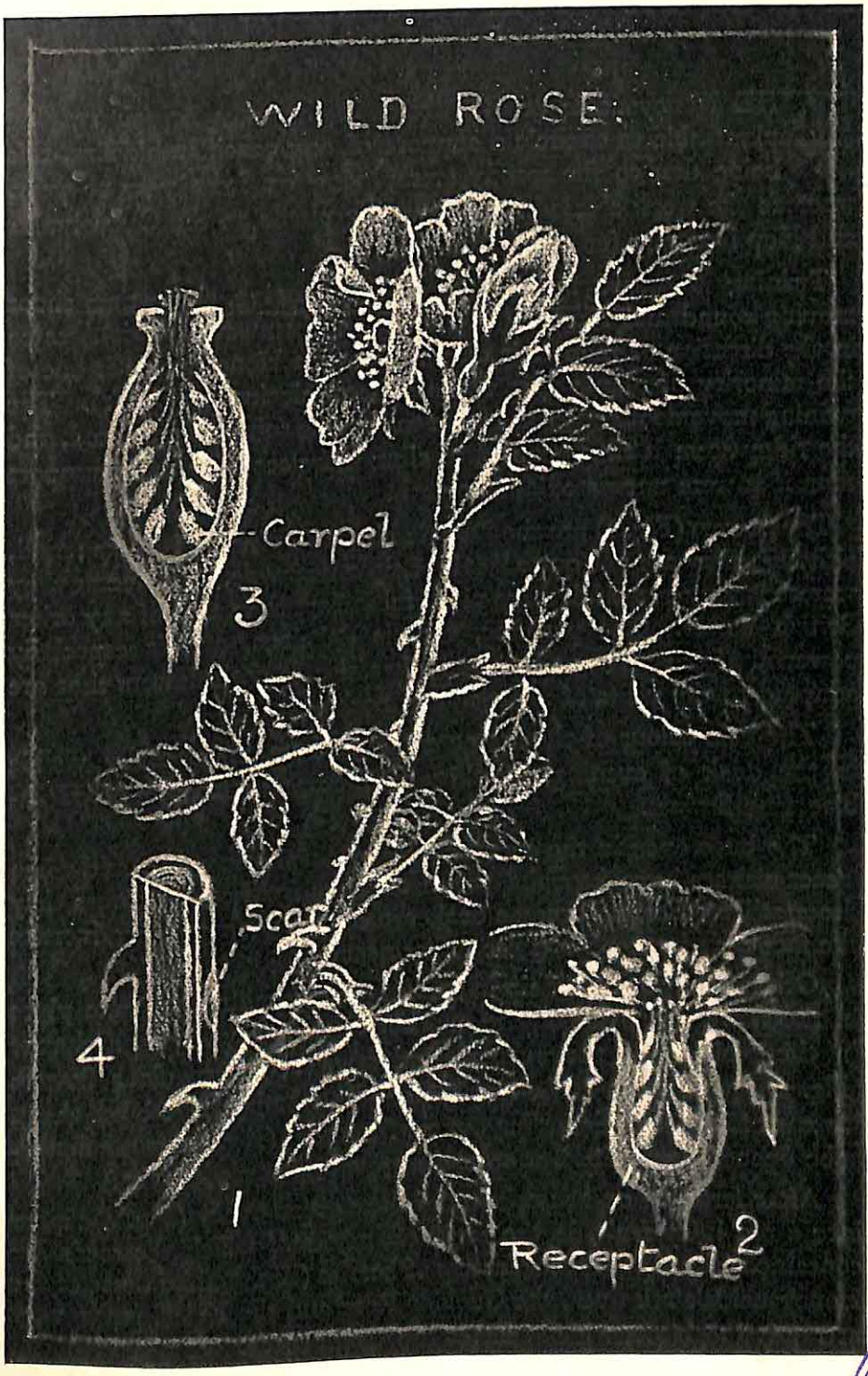
THE Rose is the national flower of England, as the Thistle is that of Scotland, the Shamrock of Ireland, and the Leek of Wales. Our garden roses are descendants of the wild roses, of which the favourite and best known is the Dog Rose (Fig. 1) with large, sweetly scented, pale pink blossoms.

As a rule such words as *dog*, *horse*, and *cow*, when forming part of a plant name, *e.g.*, cow parsnip and horse mushroom, means *coarse*, or *large*, or *inferior* ; but it is much more probable that in Dog Rose the word *dog* was originally *dag*, *i.e.*, *dagger*, the reference being to the sharp, dagger-like prickles with which the plant is armed. These prickles are thick, overgrown hairs, and being mere outgrowths of the skin (Fig. 4) they can be easily broken off, leaving a clean scar. The prickles are most plentiful and most strongly developed in those species of Rose that have the weakest stems ; the species with short stout stems bearing prickles that are scarcely more than stiff bristles. The main use of the prickles is to act as grappling hooks wherewith the feeble stem supports its load by hooking itself on to branches of stouter plants, failing which the plant sprawls helplessly on the ground. A secondary use of the prickles is the protection they afford against the attacks of browsing animals, including slugs and snails.

The Rose, like the Gorse, is sometimes called " a pollen flower," because it has no sweet nectar ; insects, *e.g.*, bees, beetles and flies, visiting it only for the plentiful pollen produced by the numerous stamens. The stamens grow from the edge of a hollow receptacle in which are enclosed a number of little hairy seed-cases or *carpels* (Figs. 2 and 3) each containing a single seed. From each carpel a thread-like style runs upwards so that the stigmas stand in a cluster at the mouth of the receptacle, where they can receive pollen. The stamens ripen at the same time as the stigmas, so that any flower can use its own pollen ; but no doubt pollen is often carried from flower to flower by insect visitors.

The green bearded sepals and the scented petals also spring from the edge of the receptacle, and after about two days the latter fade, and later, fall together with the sepals (Fig. 3). As the seeds ripen the receptacle becomes juicy and red, the *hip* then offering a feast to birds which scatter the hard fruitlets it contains. It must be borne in mind that the hip is not a true fruit ; the true fruits of the Rose being the hard, hairy bodies within.

The foliage leaves are compound (Fig. 1). The leaflets have toothed edges, and at the tip of each tooth there is a pore, from which, under special circumstances, so much moisture escapes as to appear as distinct drops which are apt to be mistaken for dew-drops.



XI. HONEYSUCKLE

THE Honeysuckle or Woodbine is the only British twining plant able to encircle a support of any considerable size, this being due to the woody stem living on from year to year, whereas the weak stems of such twining plants as the Convolvulus and Hop live only for one season.

Twining is caused by the tip of the growing, elongating shoot moving round and round in a circle; and in most cases it does so in the direction of the hands of a clock; but Honeysuckle is one of the minority of plants that twine counter-clockwise (Fig. 1). The twining movement causes the stem to become somewhat twisted, and the ridgy stem is thus enabled to cling more securely to its support than if it were untwisted and smooth.

The flowers (Fig. 1) are the " bugle blooms divine " of Keats; and, although they are not quite " full of clear bee wine," the nectar they secrete is very plentiful, more plentiful in fact than that of any other British flower. The perfume, too, is delicious, and is especially powerful after sunset, as is commonly the case with flowers that are adapted to the visits of night-flying moths.

The pale colour of the flower renders them more easily visible in the dusk of evening, another characteristic feature of night-blooming flowers.

The buds open in the evening and become horizontal; and when insect visitors have brought pollen to them from other flowers they droop still further and become darker in colour, as though to advertise the fact that further visits are unnecessary.

Other changes that help in securing cross-pollination take place in the flower from one day to another, among them being a change in the position of the anthers and stigma; for in older flowers (Fig. 2) the stamens droop and the stigma stands clear above them, instead of in their midst as in younger flowers. (Fig. 3 shows a flower-tube opened, with the five stamens growing from the walls.)

After fertilisation has taken place the green ovary (Fig. 4) ripens into a red juicy fruit, in the three chambers of which the seeds are contained (Fig. 6). These clusters of berries (Fig. 5), like those of the Honeysuckle's relatives, the Guelder Rose and the Elder, prove very attractive to birds, which scatter the tough seeds.


HONEYSUCKLE
4
5
2
3
6

XII. THE WHITE WATER LILY

THE so-called Water Lily is not included in the Lily Family if only because its flower-parts—petals, stamens, etc.—are more numerous than in the true lilies, and because its seeds contain more than one seed-leaf.

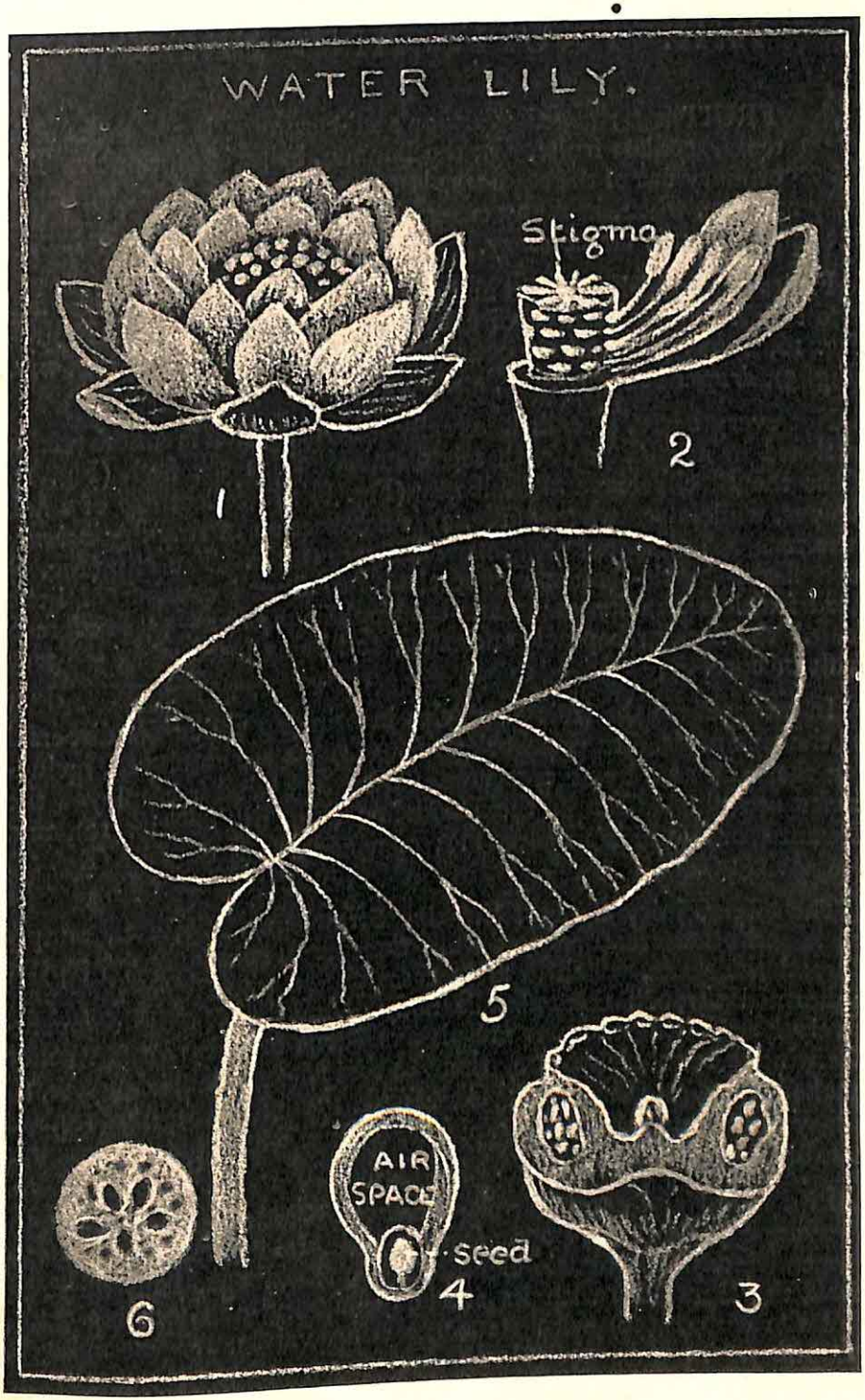
The short, thick stem is anchored to the bed of the river or pond by many rootlets, and from the stem rise the leaves and flowers, with stalks so long that the rounded leaf-blades (Fig. 5) and the beautiful blossoms (Fig. 1) float on the surface.

The end of the flower-stalk widens out into a receptacle which encloses the ovary or seed-case, the seeds being produced in a number of hollow chambers (Fig. 3, section of receptacle, showing two of these chambers). From the walls of the receptacle spring the sepals, petals and stamens (Fig. 2), the two latter passing gradually into each other, and supporting the belief that in the long history of flowers petals have developed from stamens. The rays or ridges on the summit of the receptacle form the stigma upon which pollen must be deposited if good seeds are to be formed. The pollen is very tender and is protected from damp and cold by the flowers closing during wet weather and at night.

When the fruit is ripe the stalk contracts and pulls it down through the water, after which the fruit opens and lets the seed escape. In the outer coat of the seed is a large air space (Fig. 4) so that when set free the seed rises to the surface where it floats buoyantly. Sooner or later, however, the water soaks through the coat and drives out the air, when the seed sinks to the bottom and takes root.

The stalks of the flowers and leaves are full of air spaces (Fig. 6). Being thus buoyant the whole weight of the plant is supported by the water, and hence there is no need for strengthening tissues such as the woody fibres found in land plants. The skin, too, is very thin, hence the rapidity with which the Water Lily, like all water plants, withers when exposed to the air.

The edges of the floating leaves (Fig. 5) are wavy, and this allows any water to drain quickly off the waxy upper surface, in which are all the breathing pores or *stomates*. It is through these that the plant obtains its chief supplies of oxygen as well as carbon from the air, and this is why the Water Lily perishes if long submerged, as it may be during floods. Indeed, the Water Lily is more truly a marsh plant than a water plant, so much so that it can live quite well in marshy soil. In such cases the stalks of the leaves and flowers are short, and stout enough to bear their own weight.


WATER LILY.
Stigma
1
2
5
AIR SPACE
seed
4
3
6

XIII. FRUITS AND SEEDS

A FRUIT is a ripened ovary or seed-case together with its contents, seedless fruits, *e.g.*, the Banana, being exceptional. The primary use of the seed-case is to protect the young seeds until they are ripe, when, in many cases, they are so tough and hard that such protection is unnecessary.

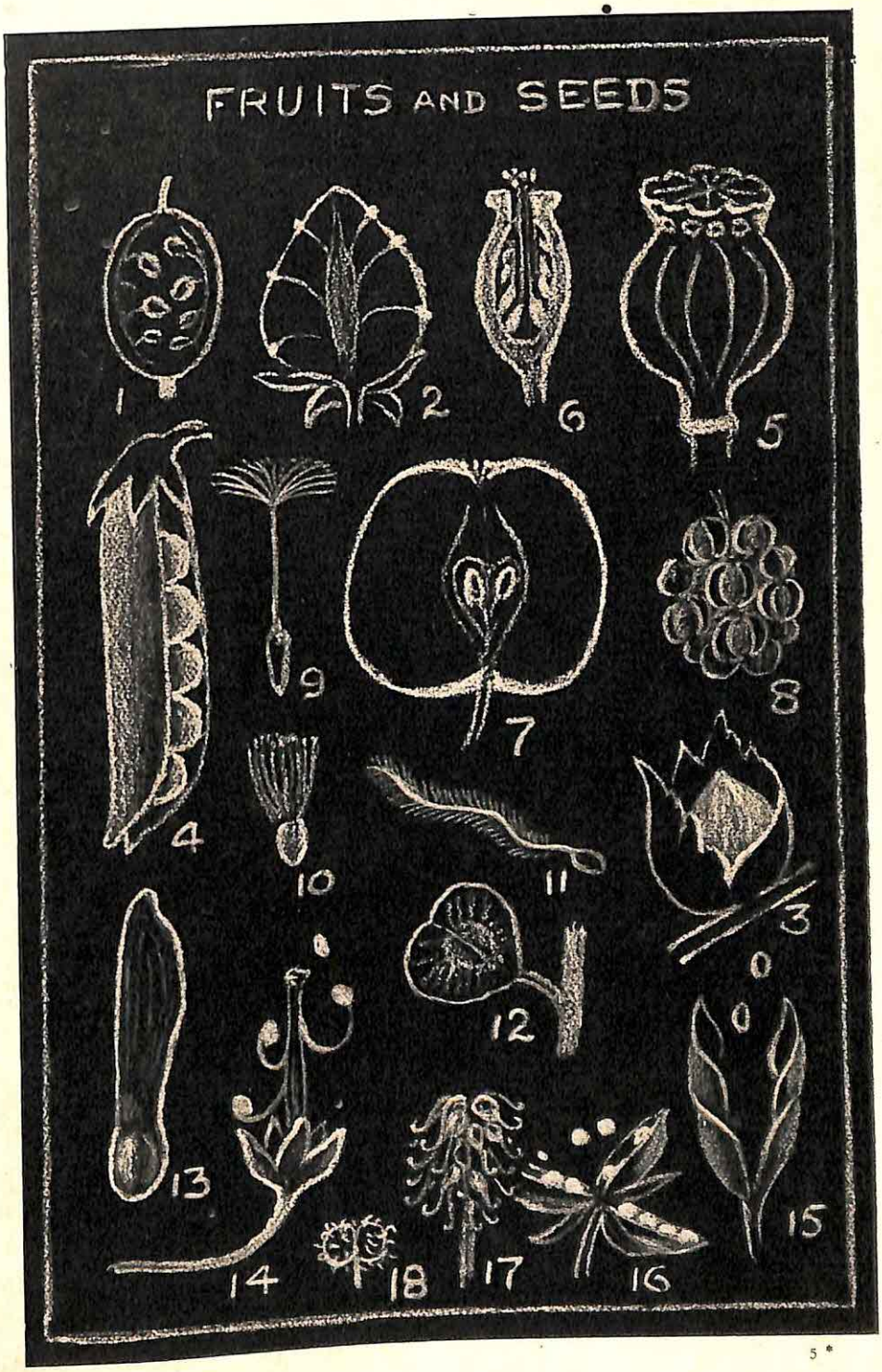
Fruits vary widely in form and structure ; and hence are classified into *berries* (Fig. 1, section of gooseberry), *capsules* (Fig. 5, Poppy ; Fig. 16, Pansy), *legumes* or pods (Fig. 4, Pea ; Fig. 15, Gorse), *nuts* (Fig. 3), *drupes* or stone-fruit, and so on.

Not every berry, so called, is really a berry, which is a fleshy fruit enclosed in a skin, and with seeds embedded in the flesh (Fig. 1). Thus the Blackberry and Mulberry (Fig. 8) are collections of small drupes, while a strawberry (Fig. 2) is a collection of tiny dry *achenes* (the true fruits) seated on the swollen receptacle. The Hip (Fig. 6) is a fleshy bottle-shaped receptacle containing a number of little hard fruitlets or achenes ; while the apple is a *pome*—a " reinforced fruit," the fleshy receptacle enclosing, and being fused with, the true fruit or core.

In many cases the fruit also helps in bringing about the dispersal of the ripe seeds. In this work various agents are employed, including the wind and living creatures. When the wind is employed the fruits are plumed, as in the Dandelion (Fig. 9), Thistle (10), and Clematis, or Old Man's Beard (11) ; or winged, as in the Elm (Fig. 12) and Ash (13).

The sweet, juicy flesh of the ripe Strawberry, Hip, etc., tempts birds and other creatures to devour them, and, subsequently, scatter abroad the seeds, which in most cases are so tough that they pass unharmed through the animal's body. And just as the comparatively heavy winged fruits are always borne on tall plants whence the wind is best able to carry them to some considerable distance, so hooked fruits, *e.g.*, those of the Geum (Fig. 17) and Goosegrass (18), are always borne on low-growing plants, against which passing animals can brush and carry them away.

In a number of cases the plant disperses its seeds unaided. The swaying capsule of the Poppy (Fig. 5) sprinkles its seeds through the " open windows," and the Geranium (14) with its suddenly bursting beak, the Gorse (15) with its suddenly bursting and twisting pods, and the Pansy (16) with its contracting valves, are examples of *catapult fruits*.


FRUITS AND SEEDS
1
2
6
5
4
9
7
8
10
11
3
12
13
14
18
17
16
15

XIV. FERNS

FERNS, such as the Common Polypody (Fig. 1) belong to the flowerless, and therefore seedless class of plants. New plants are produced by means of *spores*, produced in immense numbers on the under side of the *fronds* which vary widely in form, being quite simple and strap-like in the Hart's-tongue Fern, or much divided as in the Male Fern and Bracken.

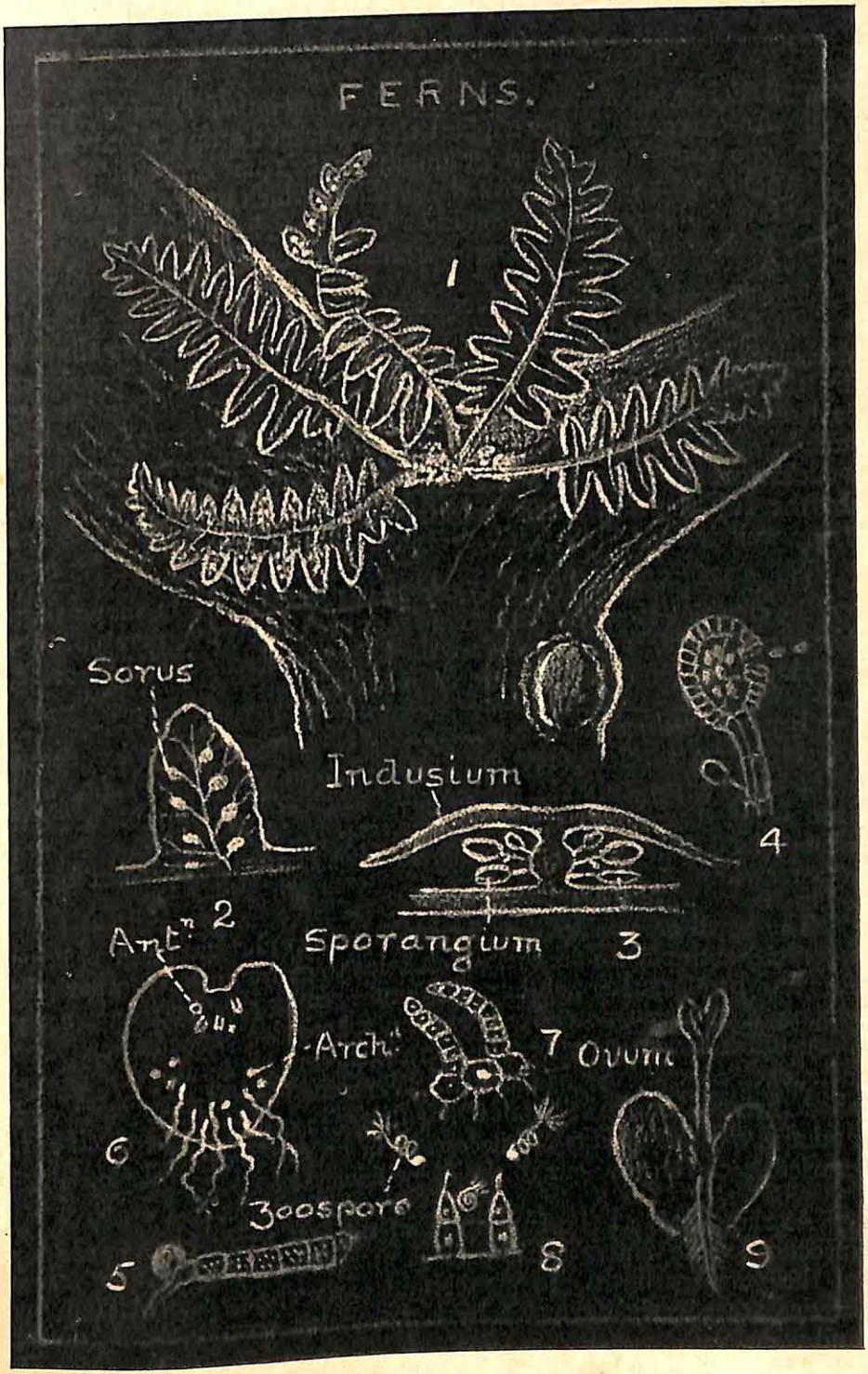
The fronds spring from a root-stock or rhizome, which does not increase in thickness year by year as do the stems of flowering plants, but simply increases in length; and it is from near the growing tip that new fronds spring each year, the remains of the dead fronds of previous years, together with chaffy scales, covering the older parts of the stem. The Polypody gets its name, which means "many feet," from its creeping and branching rhizomes, by means of which the plant spreads.

Each of the brown patches on the under side of a fern frond (Fig. 2) is called a *sorus*, and consists of a number of spore-cases (*sporangia*) covered over with a little umbrella-like structure (Fig. 3). When the spores are ripe the dry spore-case bursts, setting free the fine dust (Fig. 4) which is so light that it can be carried long distances by the slightest breeze, especially during dry weather. From the spore a tiny white shoot grows into the soil (Fig. 5); a larger green one grows towards the light, and becomes a flat, heart-shaped body (Fig. 6).

On the under side of this body a number of little pimples appear, and little rootlets grow down into the soil. Some of these little pimples (Arch. = *archegonium*) may be likened to the ovaries of flowers, while others (Ant. = *antheridium*) may be likened to anthers. Wonderful to relate the "pollen" or spores produced are provided with a spiral tail at the tip of which is a brush of minute, living hairs, and they are called *zoospores*, *i.e.*, animal spores (Fig. 8, zoospores, escaping from an antheridium), because by means of their tail they are able to swim when placed in a thin film of water such as may be found on the under side of the flat green body (*prothallus*) in damp places.

They actually do swim in such a film, and some of them find their way to the other pimples, tiny flask-shaped bodies at the bottom of which lies the ovum (Fig. 7), and wriggling their way down the neck of the flask they fertilise the ovum, as pollen fertilises the ovules of flowers.

It is from such a fertilised ovum that a young fern plant arises (Fig. 9). A tiny rootlet grows down into the soil, and a green shoot—a young frond—rises up into the light, the young fern at first living on the green heart-shaped body from which it springs, until the latter fades away and disappears.


FERNS.
1
Sorus
Indusium
4
Ant.n 2
Sporangium 3
Arch.
7 Ovum
6
Zoospore
5
8
9

XV. IVY

THE Ivy is a familiar example of an evergreen climbing plant. An evergreen is not a plant that does not drop its leaves, but one that does so so gradually that it is always clothed in green foliage, in contrast with those plants which at the approach of an unfavourable season—too cold or too dry—shed their leaves and stand bare until a more favourable season returns.

The danger to which an evergreen plant is exposed during a cold season is that it may lose more moisture from its leaves than it can obtain from the soil, owing to its root-hairs being so paralysed by the cold that they are unable to do their work. This danger is lessened or avoided by the leaves being covered with a thick, tough, glossy skin, through which very little moisture can pass, and which enables them to withstand the effects of frost and snow. In the Ivy the downward pointing position of the leaves keeps them well drained.

On flowering stems (Fig. 1) the leaves are simpler in shape than on the climbing stems (Fig. 4), where they are usually five-pointed. On the climbing stems the leaves face the light and form a kind of mosaic, overlapping each other as little as possible.

Ivy is *root-climber*. The weak stems cling to a support by means of numerous rootlets (Fig. 4), which turn away from light, and adhere to some suitable support by means of a kind of cement into which their outer cells are converted. These rootlets do not absorb food from living supports, such as trees, the Ivy not being a parasite.

The small greenish-yellow flowers borne in clusters (Fig. 1) have a somewhat unpleasant scent, which helps to attract insects, especially flies and beetles, although butterflies and moths may be seen eagerly sipping the nectar smeared over the central cushion of the flower. The parts of the flower are in fives (Fig. 2), the ovary containing five chambers, each containing a single seed. When the large anthers ripen and shed their pollen the stigma of that flower is not ready to receive it, and the visits of insects are necessary in order that pollen should be carried from the younger to the older flowers.

As the nectar of the Ivy is one of the last feasts of the year for insects, so the ripened fruits (Fig. 3) form one of the first feasts of the year for birds. In winter and early spring the black juicy berries are eagerly devoured by birds, which scatter the seeds far and wide.


IVY.
2
1
4
3

XVI. THE ELM

THE Common Elm is a familiar tree in hedgerow and park, its relative the Wych Elm or Mountain Elm being more often found at a considerable elevation, though both species flourish best in the lowlands and valleys. The Wych Elm is a true native, British tree, but that is probably not the case with the Common Elm, and those who hold that it was introduced by the Romans point to the somewhat curious fact that it seldom bears fertile seeds, but depends chiefly upon underground *suckers* for the production of new plants. This is why from a single tree in a hedgerow a whole row may arise, browsing animals, etc., destroying those that spring up from suckers in other directions.

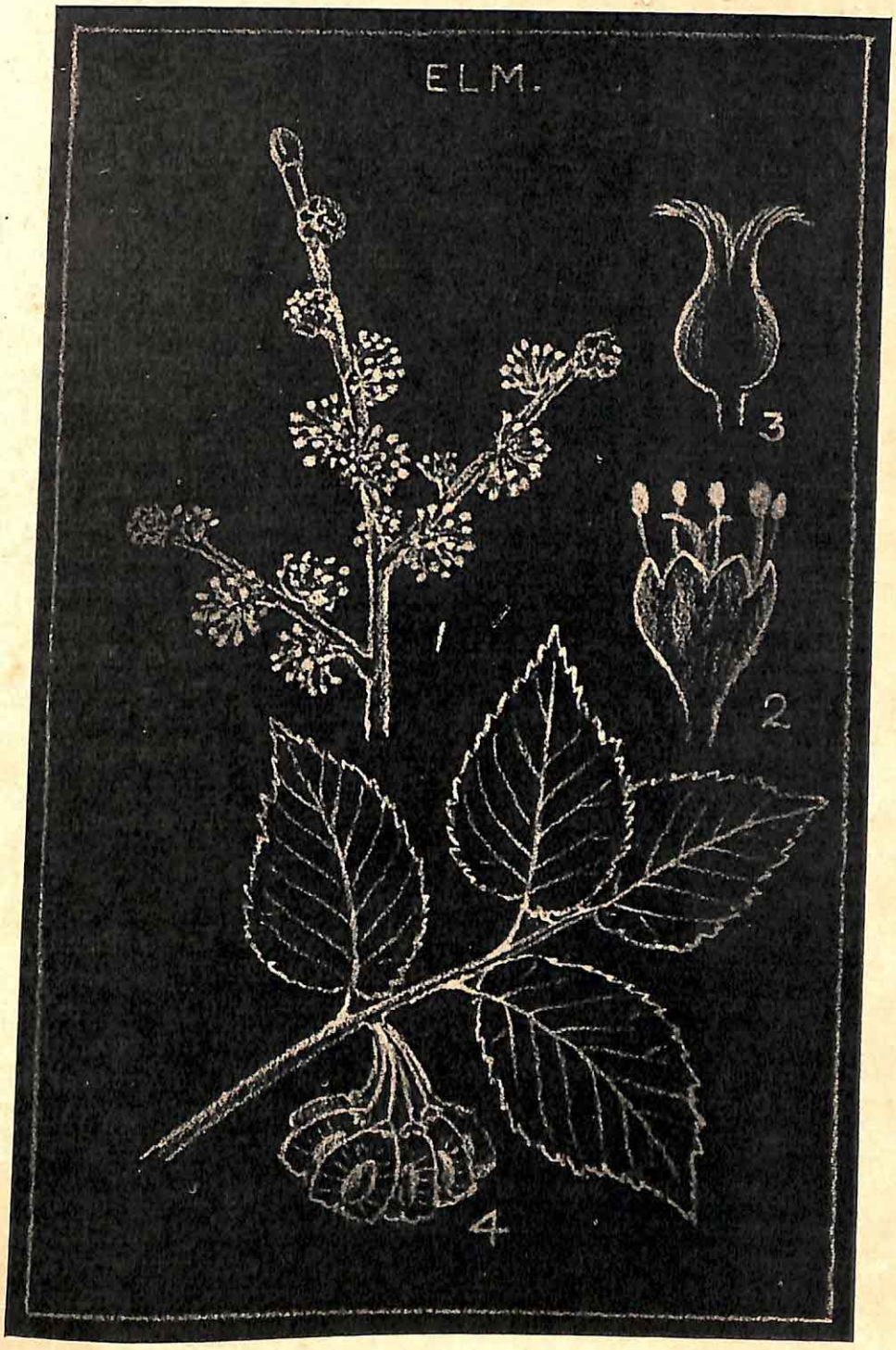
In early spring (March or April) the Elms glow with a deep wine-red colour, this being due to the myriads of tiny flowers (Fig. 1) which appear before the leaves. Each flower (Fig. 2) consists of a purple calyx, some purple stamens, and a pistil with a forked, feathery stigma (Fig. 3) whose work is to catch and hold some of the flying pollen as it is blown from the ripe anthers. The stigma is ready before the stamens of the same flower have lengthened and ripened their pollen, so that it is necessary to obtain pollen from an older flower, and this is carried to it by the wind.

While the ovule is developing into a ripe seed the flat pistil enlarges into a thin, pale, membranous fruit called a *samara* (Fig. 4). In the Common Elm these winged fruits are deeply notched, whereas those of the Wych Elm are only slightly notched, and the seed is not so nearly in the centre. Many of these winged fruits contain no seeds, and even of those that do few germinate, so that the work of the wind in carrying away the winged fruits, as in carrying pollen from flower to flower, appears to be largely wasted.

The foliage leaves (Fig. 4) are larger on one side of the mid-rib than the other, a feature which is probably connected with the fact that when in the bud the leaf is rolled up with the shorter side inside the longer. The leaf of the Common Elm is smaller than that of the Wych Elm and has a longer stalk.

On the under side, especially near the mid-rib, the leaf is covered with short hairs, which to some people are as painful when touched as those of the Stinging Nettle, to which the tree is closely related. The chief value of these hairs appears to be to catch and hold the dust, and thus prevent the breathing pores from being choked.

The light green colour of the foliage in spring gives place to a much darker green in summer, which again is replaced in autumn by a lemon yellow which causes the tree to glow in the sunshine of October when many other trees are almost if not quite bare.


ELM.
3
2
4

XVII. THE LAUREL

SEVERAL plants go under the name Laurel, all being evergreen. Of these the Common or Cherry Laurel (Fig. 1), the Portugal Laurel, and the Bay are three species grown in the British Isles, none of them, however, being native.

In texture the foliage leaves resemble those of the Ivy, the tough glossy skin serving to protect the plant against the dangers of a cold or a dry season, particularly against the danger of losing too much moisture during a period when the roots absorb very little owing either to drought, or to the effects of cold on the root hairs.

The Common or Cherry Laurel belongs to that branch of the Rose Family which includes the cherry, plum, apricot and peach, the flowers, borne on a loose spike, resembling small plum or cherry blossoms. There are five sepals joined together, five petals, and an indefinite number of stamens. Then, too, the fruits (Fig. 2) resemble small cherries, having the seed surrounded by a hard shell or " stone " which is enclosed in a juicy flesh. Such fruits are called *drupes*.

The Portugal Laurel also belongs to the Prune Family, but can easily be distinguished from the Common Laurel by its leaves being smaller and darker in colour ; and it is a much hardier plant, resisting the severest frosts before which the Common Laurel would shrink and perish.

The Bay tree, however, is not a member of the Rose Family. It is really the Noble Laurel, and belongs to the Laurel Family, having very little in common with the other so-called laurels except in being an evergreen. One striking difference is in the nature of its fruit, which is a *berry*, and another is in the nature of the leaves which when crushed have an agreeable smell, whereas that of the Common Laurel is by no means agreeable, and may cause sneezing.

The bitter almond taste of the Common Laurel tells us that they contain prussic acid, and it is for this reason that crushed laurel leaves in stoppered bottles are used for killing butterflies and moths. They are also used for giving an almond flavour to custards, blanc-manges, etc., but such dangerous flavouring should be sparingly used.


LAUREL.
2

XVIII. THE ASH

THE Ash is one of the most graceful as well as useful of our forest trees, Virgil of old declaring that "the towering Ash is fairest in the woods." Its graceful beauty is partly due to the shape of the branches which, after sweeping downwards and outwards, curve up again at the tips. In colour the smooth bark is ashen grey, to which fact it is said the tree owes its name.

From the short, stout black buds (Tennyson describes Juliet's hair as being "More black than ash-buds in the front of March") come the handsome compound leaves (Fig. 4) which are among the latest to appear and the earliest to fall.

> "The tender ash delays
> To clothe herself when all the woods are green."

The Ash is a true native, and as such is more perfectly adapted to the British climate, especially to the cold blasts of early spring which often injure the more precocious trees, most of which are foreigners from warmer lands, and have not yet given up their habit of early leafing.

Long before the leaf-buds open the clusters of small purplish blossoms appear (Fig. 1). They are as simple as those of catkins; they possess neither sepals nor petals, some contain stamens only, some pistils only (Fig. 2), while others contain both pistil and stamens. As in the Elm, pollen is carried by the wind from flower to flower, and as in all wind-pollinated flowers the greater part of the pollen is wasted, as far as the tree itself is concerned.

As the seed ripens the wall of the ovary or seed-case grows out into a long strap-shaped body (Fig. 3), this wing often being so twisted as to cause the falling fruit to spin through the air and travel further than it otherwise would do. As many of the seeds are fertile a plentiful supply of seedlings may be found around and at some distance from the parent tree.

Few trees become useful so soon as the Ash, which is fit for walking sticks at four years, for spade handles at nine, and when three inches in diameter the timber is as valuable as that of the largest tree. Nevertheless few trees are less welcome to the farmer in the hedgerows of his arable land, for few trees do more harm to vegetation beneath their shade owing to the dense mass of roots it sends out in all directions just below the surface of the soil.


ASH
2
4
1
3

XIX. THE OAK

LIKE the Ash and the Wych Elm the Oak is a true Britisher, and like them it is prudent in the matter of opening its leaf-buds, being much later in this respect than the majority of our forest trees. There is a widespread weather proverb to the effect that

> "If the oak's before the ash
> Then you'll only get a splash;
> But if the ash precede the oak
> Then you may expect a soak"

—the "splash" and the "soak" referring to the weather of the ensuing summer. But this proverb is rather a subject for testing than for belief.

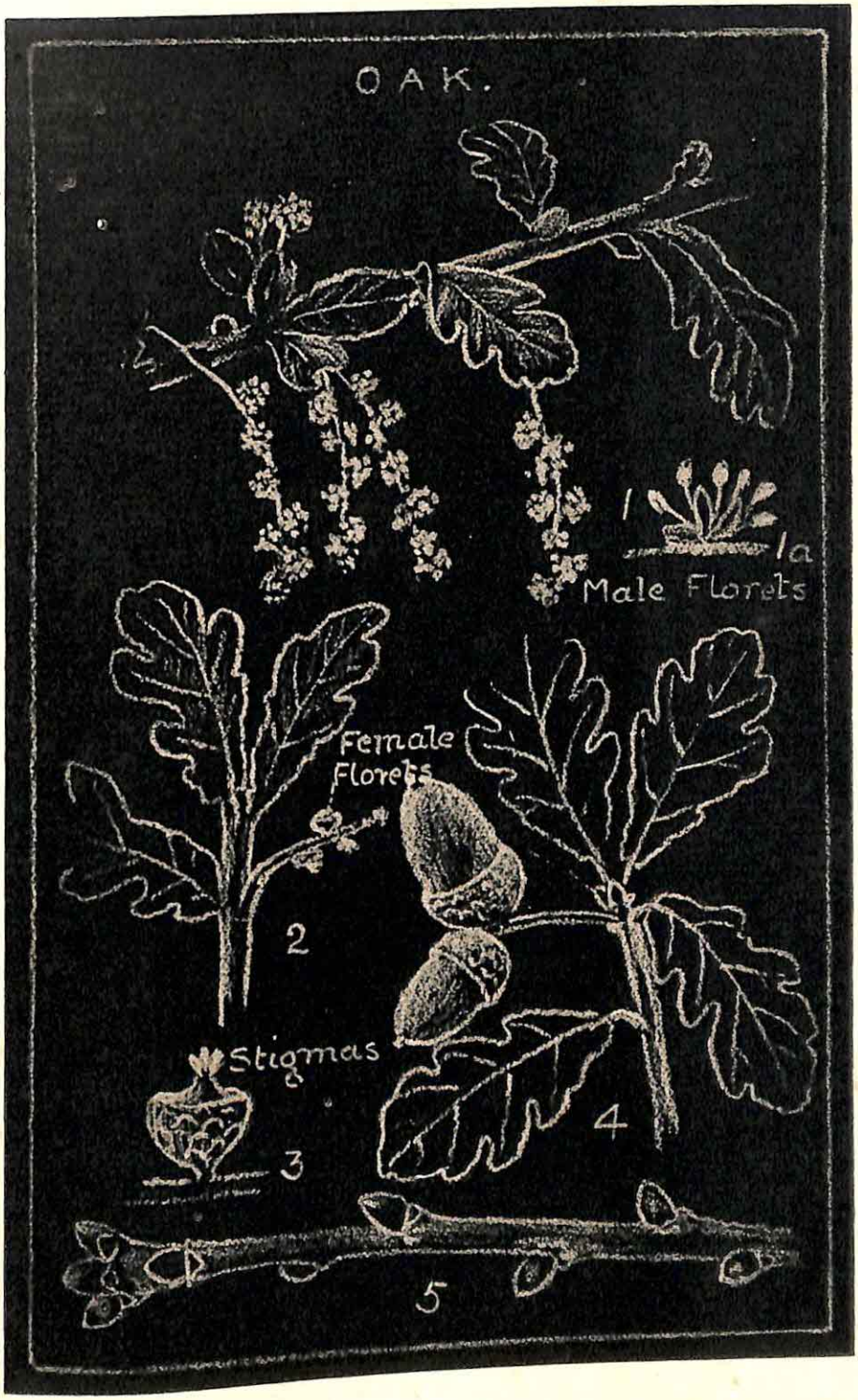
With the young foliage leaves in April or May appear the simple flowers, these being of two kinds, male flowers consisting of stamens clustered into catkins (Figs. 1 and 1a) and female flowers (Fig. 2) which like those of the Hazel are often overlooked. Each female flower (Fig. 3) contains an ovary with three seed-chambers, each surmounted with a style, the whole being surrounded by a number of overlapping scales. From the male flowers the pollen is carried by the wind to the female flowers which develop into acorns (Fig. 4), nut-like fruits set in scaly cups which form no part of the fruit itself. The name of the tree was in Anglo-Saxon *Ac*, and, according to some, originally belonged to the fruit, being transferred later to the tree; but more probably the word *acorn* simply means the corn or fruit of the *Ac* or oak.

As the fruit ripens sap ceases to flow into it, and it shrinks until it is so loose in its cup that a slight gust of wind is sufficient to throw it out. The little marks on the broad end of the acorn show where the sap vessels entered it from the stalk.

The foliage leaves have scalloped edges, and are larger on one side than the other, both facts being connected with the folding of the leaf in the bud, a large leaf with a scalloped edge being capable of much closer packing in a small bud than if unscalloped.

In one of the two chief species of Oak the leaf is stalked but the fruit is stalkless, while the contrary is the case in the other, this latter species being most common in the north and west, and on the higher grounds of the southern part of our country.

The buds are arranged along the stem in spirals, five to a spiral, which passes twice round the stem (Fig. 5). Such a leaf arrangement is, therefore, said to be $\frac{2}{5}$, the numerator giving the number of turns in the spiral, and the denominator the number of buds.


OAK.
1
1a
Male Florets
Female Florets
2
Stigmas
3
4
5

XX. THE LIME

THE Lime is the "summer home of murmurous wings" owing to the abundance of nectar poured out by the numerous flowers, to whose delicious perfume the tree largely owes its popularity. It is fortunate for those who love to see it bordering our streets, and in our city gardens, that the Lime stands the smoke so well.

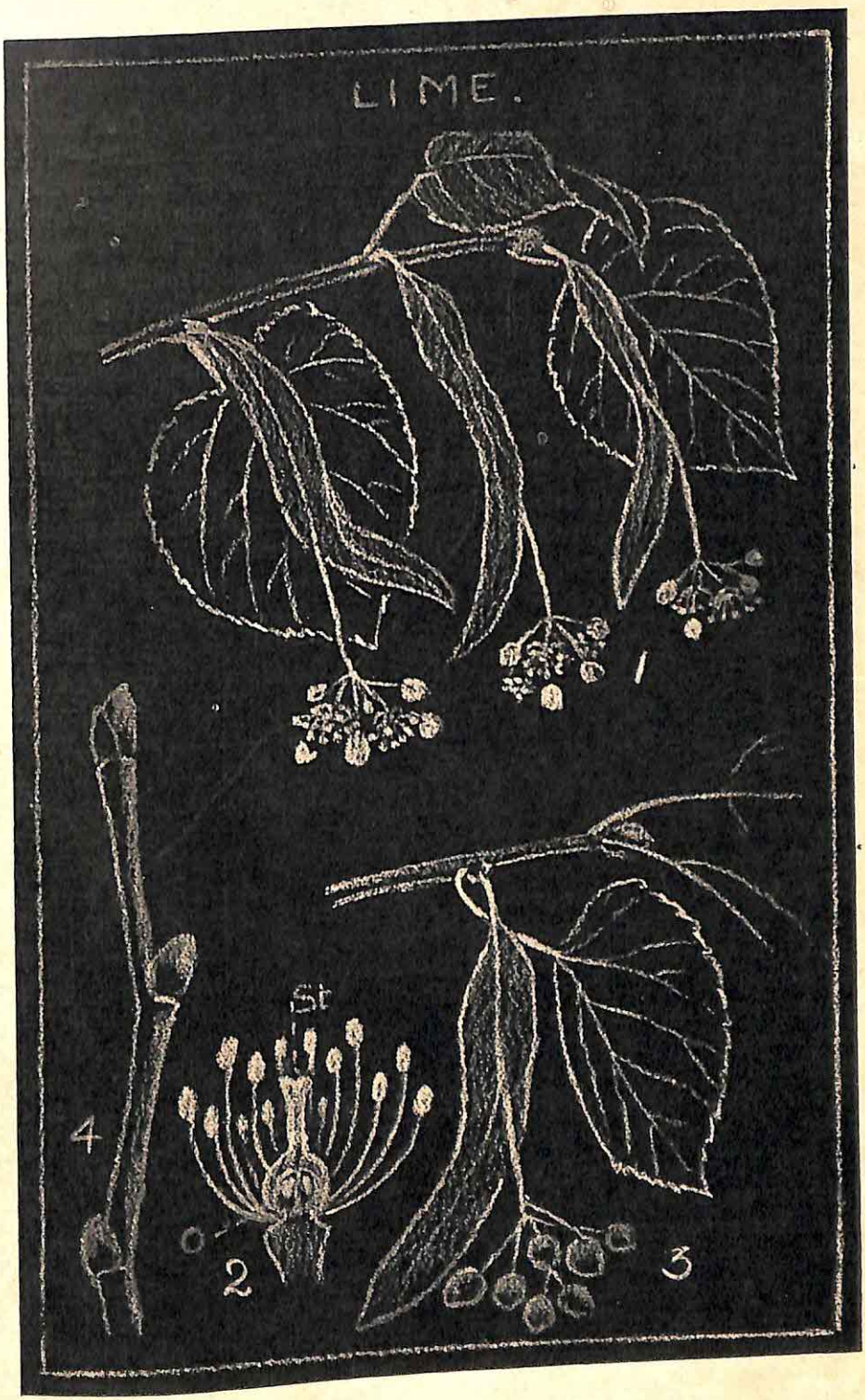
The greenish-yellow blossoms (Fig. 1) are borne in clusters at the end of a long, slender stalk bordered by a leafy bract, which is free for a considerable part of its length. There are five small sepals, five small petals, and numerous stamens (Fig. 2), while from the rounded ovary springs a style with a five-pointed stigma. The anthers of any given flower are ripe and discharge their pollen before the stigma is ready to receive it; so that it is necessary for pollen to be carried from younger flowers to older ones. This is done by insects, especially by the bees that may be seen in swarms sitting "on the blooms extracting liquid sweets deliciously."

It is a rather curious fact that the perfume of the Lime is stronger at some considerable distance from the tree than near to it, this being due to the action of the air (the oxygen, or the moisture, or both) on the odorous particles as they diffuse through it. So delightful is this perfume that Landor declared: "The flowers of the Linden should be the only incense offered up in the churches of God."

The dry rounded fruits (Fig. 3) contain one or two seeds only, and these ripen only when the summer is fine and warm. The leafy bract acts as a kind of combined parachute and propeller, thus carrying the somewhat heavy fruitlets some distance from the parent tree when anything in the nature of a considerable breeze is blowing.

As in the case of the Elm and the Oak, the two halves of the leaf (Figs. 1 and 3) are unequal, the smaller side being folded within the other when in the bud. The leaves are arranged alternately along the branches, and offer many splendid examples of *leaf mosaics*, thus overlapping each other as little as possible.

The name *Lime* was originally *Line*, which is related to the word *Linden*, and its original meaning was *pliant*, the reference being to the bast that was used in making cordage, fishing nets, and many other useful things. To its rapid growth the timber owes its softness and this together with its white colour and rather close grain renders it valuable for carving, some of the finest examples of which are those of Grinling Gibbons in St. Paul's, Windsor Castle, Trinity College, Oxford, and Chatsworth.


LIME.
St
4
2
3

XXI. THE YEW

THE Yew is a true native of Britain, and what the Oak was in the days of Nelson, the Yew was to our earlier ancestors—" the basis of their strength." So great was the importance attached to a good supply of yew wherewith to make the famous long-bows in which the English trusted for their defence that not only was the growth of the tree encouraged, but merchants were forced to import a given quantity of staves for every ton of goods brought from countries where the Yew was known to grow. Its value for this particular purpose was due to its combination of hardness, toughness, elasticity, and flexibility—qualities closely related to its extreme slowness of growth.

The original meaning of the name Yew is believed to be *verdure* or *evergreen*. From the ill effects of a cold season the Yew is doubly protected, the leaves being very small and narrow, almost needle-like, and covered with thick tough skin. On most of the branches (Figs. 1, 5 and 8) the leaves are arranged like the teeth of a double comb, which they resemble in shape.

The flowers appear in March and April—male flowers in masses on the under side of the twigs (Fig. 1) and female at the end of little twigs (Fig. 5), and usually on different trees. The male flowers (Fig. 2) consist of a scaly bud with a number of stamens seated upon it, each stamen being in shape something like a tiny umbrella with a number of pollen sacs hanging down from it (Fig. 3). In dry weather these umbrellas open, the pollen sacs burst, setting free a cloud of very fine, dry pollen—the " living smoke " of Tennyson (Fig. 2), which is easily carried considerable distances by the lightest breeze. (Fig. 4 shows an anther with the pollen sacs open and empty.)

In the female flower (Fig. 6), which somewhat resembles a small acorn, there is no seed-case, the ovule or young seed being quite naked. Just at the time when the pollen is set free the female flower pours out a drop of sticky fluid, which on a sunny morning sparkles like a dewdrop, and on these sticky drops the flying pollen is caught and safely held. At the base of the ovule is a ring which, as the seed ripens, grows into a juicy, red cup—the *aril*, commonly called the fruit. (Fig. 7 shows an *aril* developing; Fig. 8, the cup full grown.)

The juicy *aril* may be eaten with safety, but the same cannot be said for the seed, which has a nutty flavour, for while some say it is harmless others declare it to be poisonous. It is certain that the foliage is poisonous, and much harm has been done to cattle browsing on it, partly owing to its poisonous nature, and partly owing to the inflammation set up by the stiff pointed leaves, especially the older foliage.


YEW.
M
F
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5
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7
6

XXII. HAWTHORN

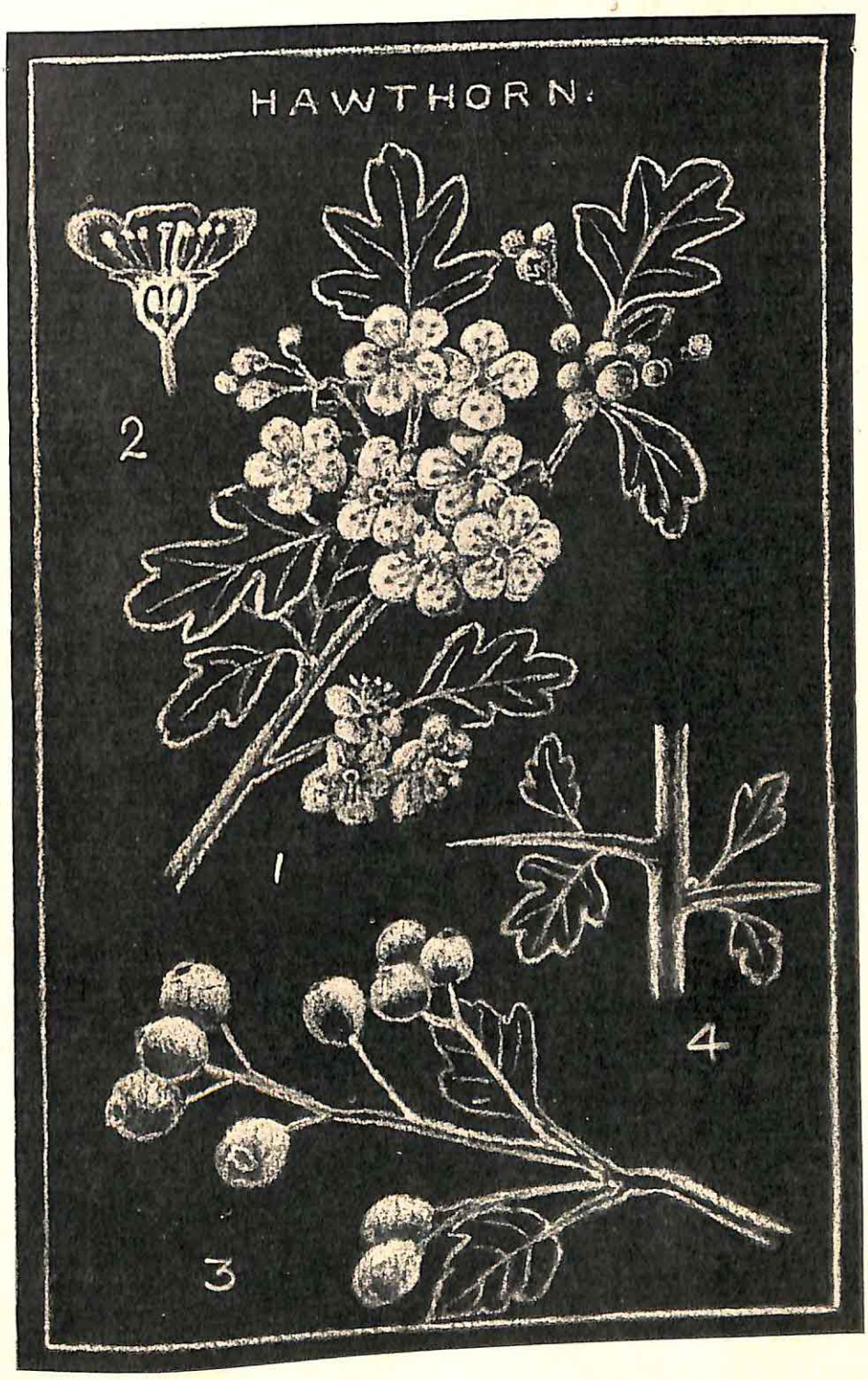
THE Hawthorn is the *Hæg Thorn, i.e.*, the Hedge-thorn of our Anglo-Saxon forefathers, the name being due to its use in making of hedges and to its armature of stout thorns. According to some, the name *Quickset* given to such hedges refers to their rapid growth ; but to others it is the " living " fence as contrasted with a dead fence or wall. (Cf. the Biblical " The quick and the dead.") The botanical name *Crategus* is from the Greek *Kratos*, strength ; the reference being to the hardness and toughness of the wood, which qualities render it useful in the making of walking sticks, the cogs of wooden mill wheels, and so on. Of the popular names *May* and *Whitethorn*, the former is that of the month in which its blossoms are most abundant, while the latter is due to the pale colour of the bark as contrasted with that of its relative the Blackthorn.

The flowers (Fig. 1) resemble small roses, but with a smell that indicates the presence of prussic acid; as is the case with a considerable number of the members of the Rose Family, especially the Peach group. The white blossoms are beautified by the crimson anthers of the numerous stamens ranged in a double row round the edge of the swollen flower-receptacle (Fig. 2) in which is embedded the seed-case, from the summit of which spring two styles.

During bright weather the stamens spread outwards carrying the anthers away from the central pillar, and laying bare the nectar, which in dull weather is concealed and protected by the stamens curling inwards, and by the woolly hairs that surround the base of the styles. Insect visitors in search of nectar carry pollen from flower to flower.

When ripe the fruits of the Hawthorn (Fig. 3) have a glossy red skin that renders them very attractive to fruit-loving birds, which feed upon the somewhat mealy flesh, which is really the swollen receptacle rather than the seed-case proper. This latter is the hard shell enclosing the seeds, which it enables to pass unharmed through the bodies of birds, which scatter them far from the parent plant.

The thorns (Fig. 4) are dwarf shoots or branches (not mere outgrowths from the skin or bark as in the case of the prickles of the Rose and Bramble), as is indicated by the fact that they not only spring from the axils of leaves, but themselves bear leaves.


HAWTHORN.
2
1
4
3

XXIII. THE EARTHWORM

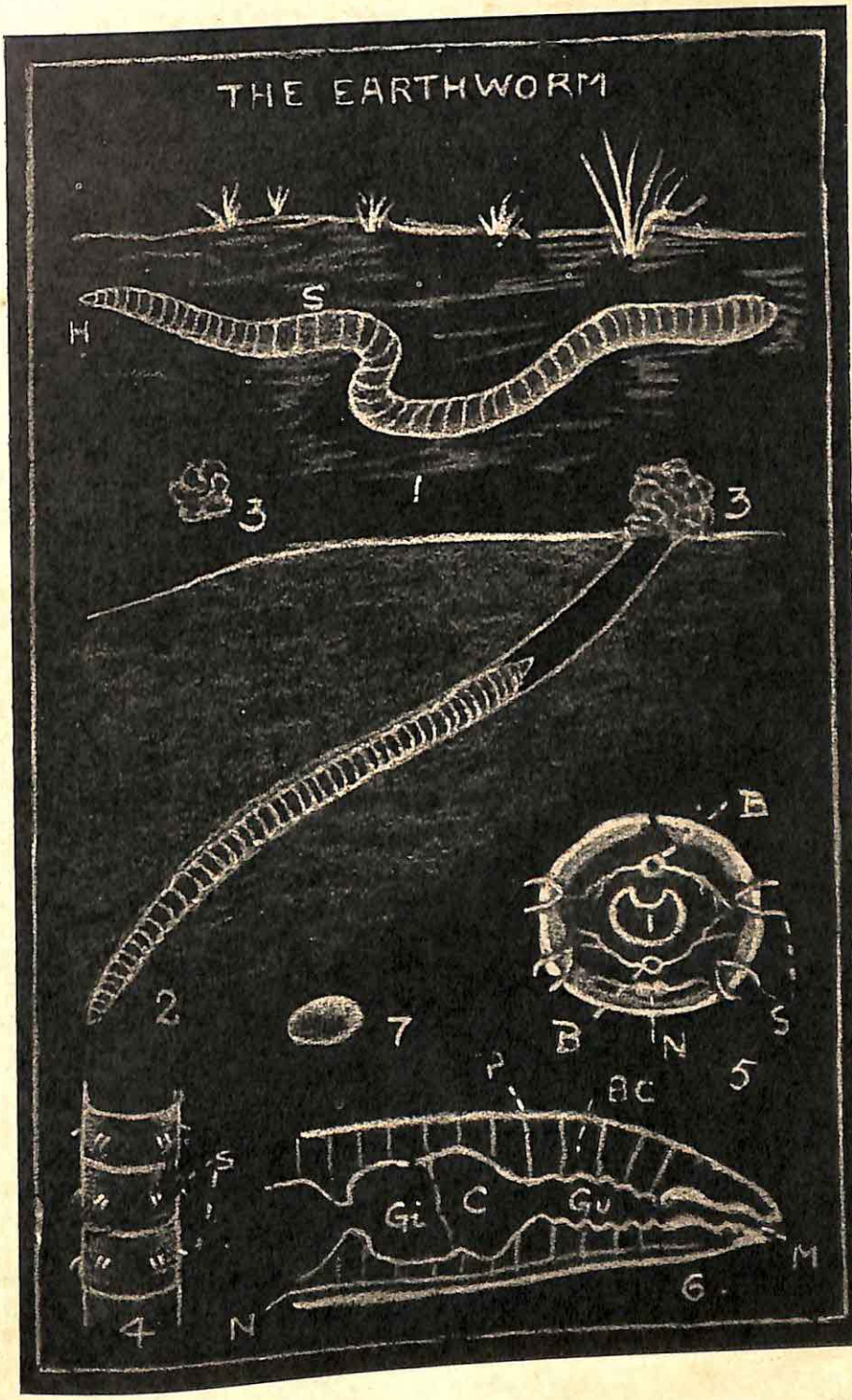
OF the backboneless creatures (*Invertebrata*) the worms form a group called *Annelids*, *i.e.*, ringed creatures, because the body consists of a number of rings or segments (Figs. 1 and 2). Of these ringed creatures the Earthworms form a special section called "bristle-feet," for a reason to be presently observed.

The naked skin is not only moist, but slimy, owing to certain glands in the skin pouring out a quantity of *mucus* on the surface. This mucus not only prevents a too rapid evaporation of moisture, which would be fatal, but also aids the creature when burrowing through the soil. Under the skin are two layers of muscle (Fig. 5, cross section) which enable the worm to contract or elongate its body at will; and as it does this it clings to the rough surface over which it is moving by a number of small bristles or *setæ* (Figs. 4 and 5, S) which protrude in pairs, four pairs to each segment or ring, except those composing the pale-coloured portion of the front half of the body (Fig. 1, S = saddle). It is by means of these "bristle feet" that the worm "walks," and it is by them that it clings to the walls of its burrow or climbs up and down in it. The Earthworm is a nocturnal creature, the surface of the soil during the day being too dry and in other ways too dangerous. Its food consists of decaying organic matter found in the soil, which is swallowed, passed completely through the body, and ejected in the form of the familiar "castings" (Fig. 3).

(Fig. 6 is a longitudinal section showing the toothless mouth, M; gullet, Gu; crop, C; gizzard, Gi; body cavity, BC, divided up by partitions, P. Along the ventral surface runs the nerve, N. Fig. 5 is a cross section showing the relative positions of the intestine, I; blood vessels, B; and nerve, N.)

The Earthworm has no eyes, and, although its skin is sensitive to light, its chief senses are those of smell and touch, the latter enabling the worm to feel the slightest jarring or shaking of the soil. Earthworms are of immense value to cultivators of the soil. Their fine castings constitute a valuable manure, their numerous tunnels give the air easy access to the soil which they also help to drain; while the myriads of leaves, etc., dragged into the burrows to rot more than compensate for the organic matter absorbed from the soil.

Four eggs are produced, and passed out of the body into a girdle produced by and encircling the "saddle." Whereupon the worm withdraws backwards out of this girdle, the two ends of which close up and form a cocoon (Fig. 7). Of the four eggs only one hatches out.


THE EARTHWORM
H
S
1
3
3
2
7
B
B
N
S
5
P
BC
S
Gi
C
Gu
M
6
4
N

XXIV. SNAILS AND SLUGS

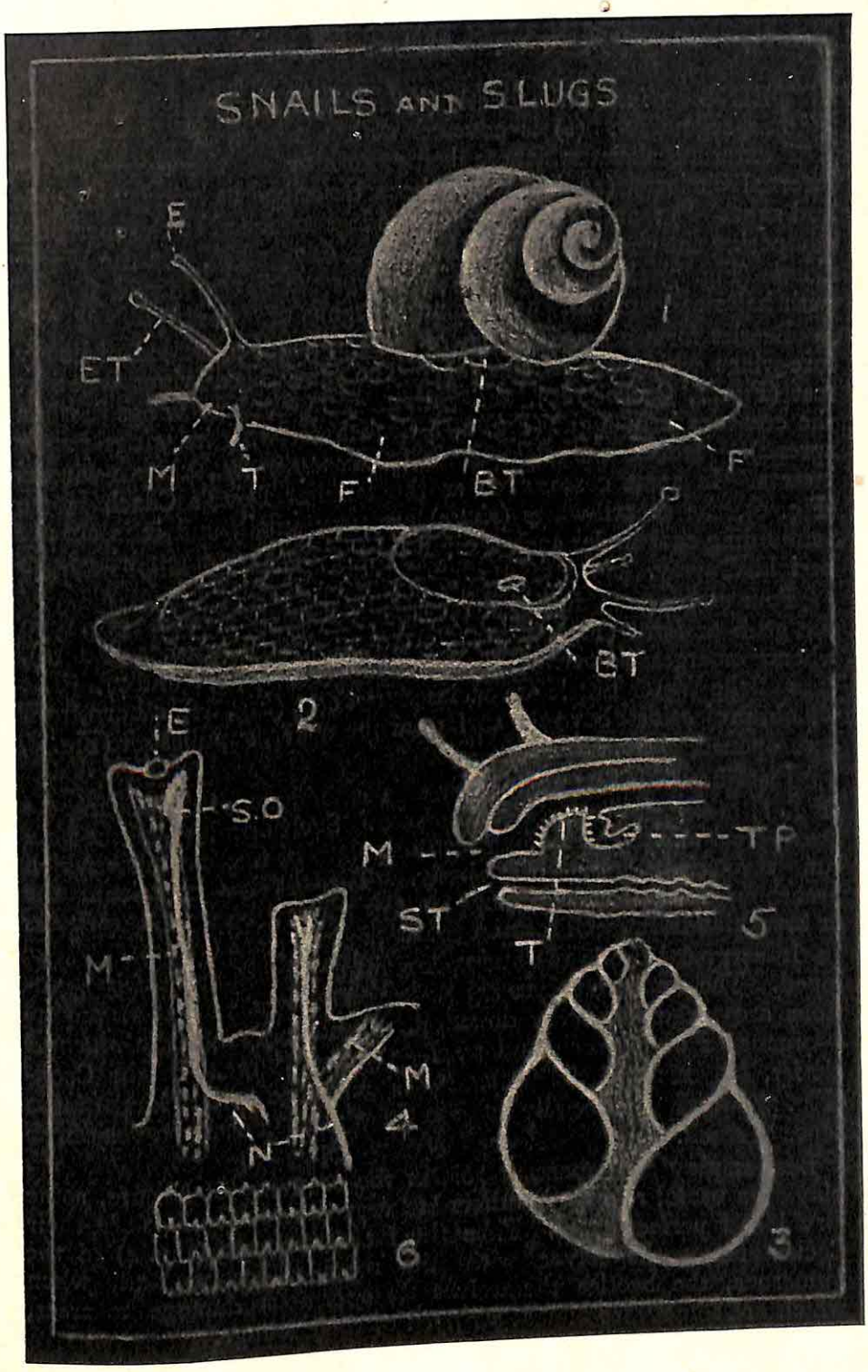
SNAILS and Slugs belong to the great class of soft-bodied creatures called *Molluscs*, most of which live in water. In the Snail the soft body is protected by a shell in one piece; spirally coiled (Fig. 1); but in the Slug (Fig. 2) the shell is almost or completely absent. The fine lines on the surface of the shell, running parallel with the coils, are lines of growth. (Fig. 3 is a section of a snail shell showing the increasing size of the body chamber from the summit, and the central column, or *columella*.)

That portion of the Snail or Slug upon which the creature glides along is called the *foot* (Fig. 1, F); and it really moves along on a track of slime poured out from a channel running along the centre of the foot and opening just below the mouth. (Fig. 5, longitudinal section of head, ST = slime tube). Progress is made by a rapid series of wave-like movements of the sole of the foot, which can be easily watched by causing a snail or slug to crawl up a sheet of glass.

There are two pairs of *tentacles* or "horns," a longer and a shorter pair (Fig. 1, ET and T), each containing a large nerve (Fig. 4, N) with a swollen tip (SO), which acts as an organ of smell. In addition, each of the larger tentacles has a small eye (Figs. 1 and 4, E). By means of a muscle (M) the horns can be pulled down into the head out of harm's way.

The sense of vision is probably very weak, the sense of smell being depended on in the search for food, as is often the case with nocturnal creatures, both Snails and Slugs usually lying concealed during the day. The food is rasped into fragments by the tongue (Fig. 5, T), a horny sheet covered with an immense number of hard scales or teeth. (Fig. 6 shows a portion of the tongue or *radula* greatly enlarged.) The tongue grows from a pocket (TP = tongue pocket), so that as the front teeth are worn away new ones take their place.

The opening of the breathing tube can be seen in the Snail just below the shell when the foot is protruded (Fig. 1, BT) and in the shield-like portion of the Slug (Fig. 2, BT). When, in autumn, the Snail passes into a state of torpor and forms a protective shield filling the entrance to the shell, a narrow slit is left in the shell through which what little air is needed finds its way.


SNAILS AND SLUGS
E
ET
M
T
F
BT
F
1
P
Q
BT
E
2
S.O
M
TP
ST
T
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M
M
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N
6
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XXV. BEETLES

BEING an *insect*, the Beetle (*a*) has its body composed of rings or segments; (*b*) is covered with a tough skin forming an external skeleton, there being nothing in the shape of an internal skeleton (an insect has been described as being "all skin and squash"); and (*c*) has six jointed legs attached to the segments composing the chest or thorax (Figs. 1, 2, 6, 7 and 9). In the Water Beetle (Fig. 7) the two hind pairs of legs are flattened and fringed with hairs to form efficient swimming organs or "oars."

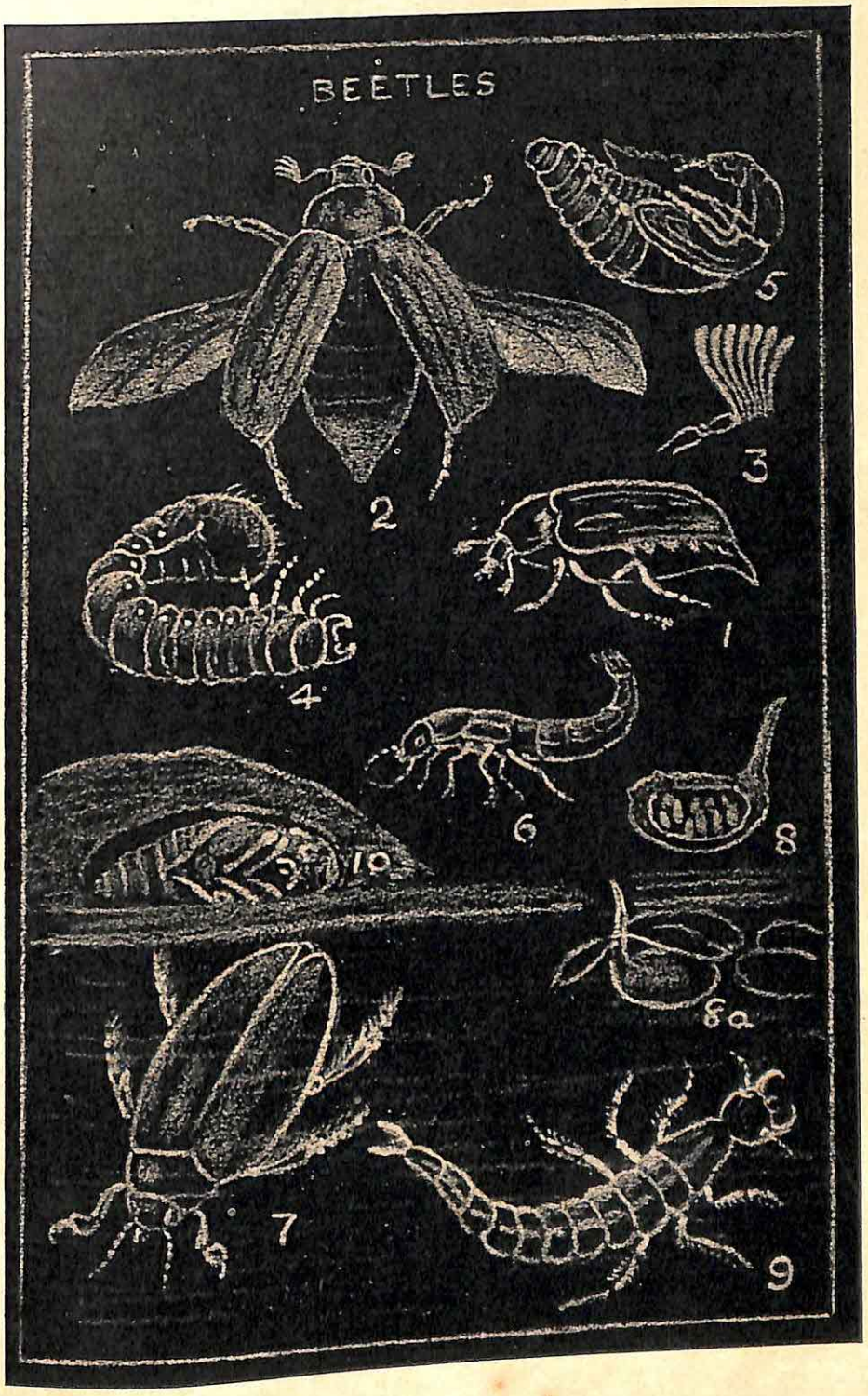
Beetles form a special class of insects, being possessed of horny fore-wings which act as sheaths to the filmy hind wings when at rest (Fig. 1, Cockchafer), and acting as "aeroplane wings" when the creature is in flight (Fig. 2, a Cockchafer with its wings partly spread). Hence the class name, *Coleoptera*, *i.e.*, sheath-winged insects. In some cases, such as the familiar Devil's Coach Horse (Fig. 6), the sheath-wings (*elytra*) are very small, and it is simply astounding that under such a small cover such large flight-wings can be folded away.

Four stages go to the life-history of the Beetle. First the egg, then the grub or *larva* (Figs. 4 and 9), then the *pupa* (Figs. 5 and 10), whence emerges the perfect insect or *imago* (Figs. 1, 2, 6 and 7). The eggs of the Water Beetle are enclosed in a case (Fig. 8a), a horn from which, projecting above the surface of the water, supplies air (Fig. 8, case opened, showing eggs).

Just above the five white spots on the abdomen of the Cockchafer (Fig. 1) a row of openings can be seen. Such openings in the skin are typical of insects, leading into a system of fine air tubes which run throughout the entire body. These tubes constitute the breathing system, the openings on the surface being the *spiracles* or breathing holes, well seen on the Cockchafer grub (Fig. 4).

In a typical beetle the senses of sight and smell are highly developed. The compound eyes are large and convex, so that some portions are turned in every direction. In some species the *antennæ* —organs of both touch and smell—are very large. In the Cockchafer, for example, the antennæ are expanded into a kind of fan (Fig. 3), which is especially large in the male, indicating a very keen sense of smell.

Beetles play an important rôle in the economy of Nature, some playing a useful rôle while others are very destructive, both in their larval and perfect state. Thus the fat white grub (Fig. 4) of the Cockchafer works havoc with the roots of crops, and, when numerous, the beetles themselves do enormous damage to trees, which are sometimes almost stripped of their foliage.


BEETLES
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8a
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XXVI. THE HONEY-BEE

BEES (Figs. 1 and 2) are "skin-winged" insects (*Hymenoptera*), and the two thin membranous wings on either side are hooked together to form one very efficient wing on which the bee travels fast and far in search of nectar and pollen. The hooks are borne on the front margin of the hinder wing, and fit into a fold on the hinder margin of the front wing (Fig. 5). When at rest the wings fold up closely like a fan so that they offer no obstacle to the bee's entrance to a flower or other confined space.

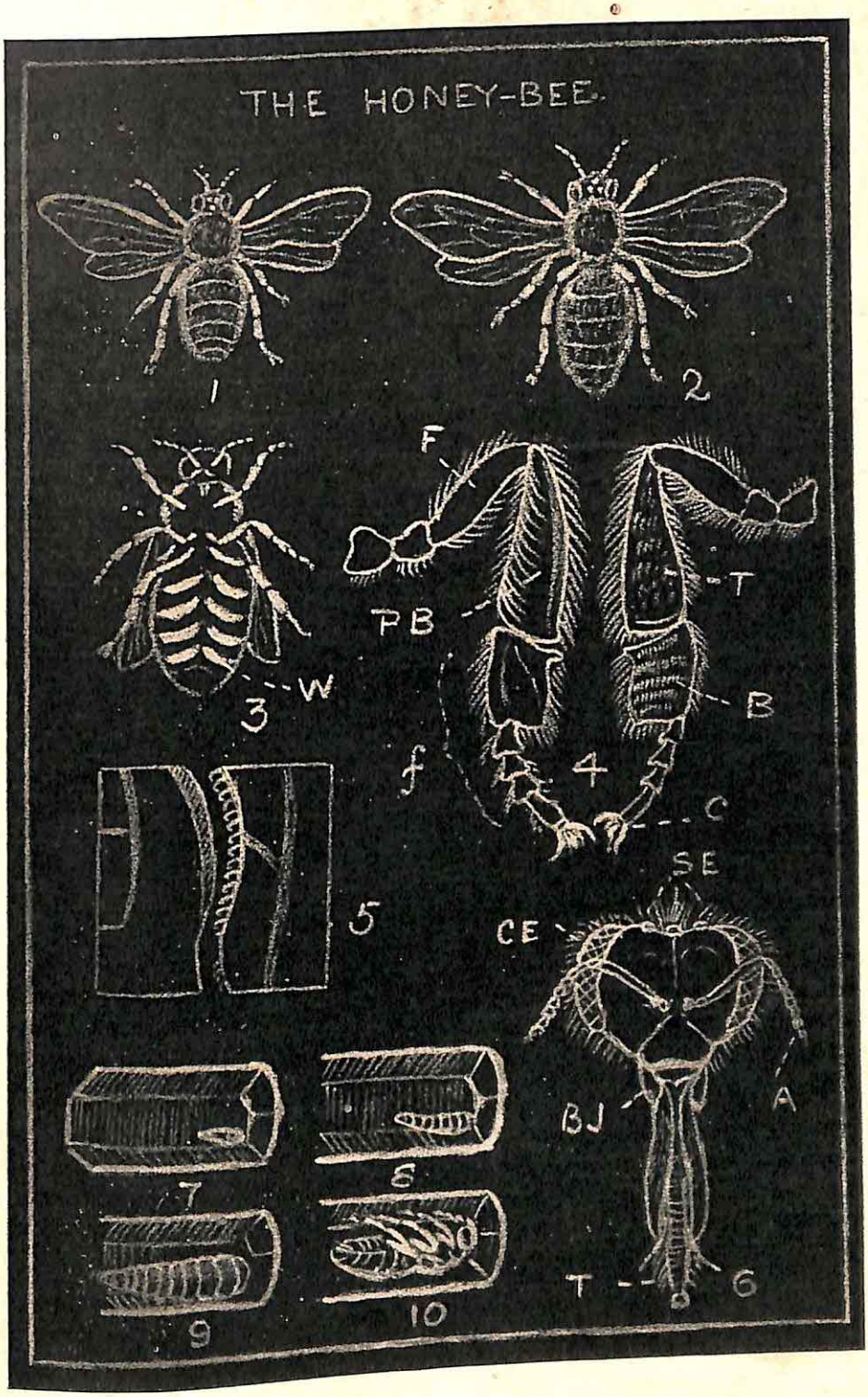
In the search for food large compound eyes (Fig. 6, CE) and sensitive antennæ (Fig. 6, A) play their part, the former being aided by the simple eyes (SE) situated on the upper surface of the head.

The mouth parts folded together form a tube within which the long hairy tongue (Fig. 6, T) is worked backwards and forwards. With the tongue nectar is licked up, carried into the tube, where it is sucked into the honey bag. When not in use this apparatus is coiled up out of the way, leaving the pincer-like jaws (mandibles or biting jaws, Fig. 6, BJ) free to detach pollen or to work in the making of the honeycomb.

The wax of which the honeycomb is made is formed within the body, whence it exudes in the form of thin plates between the body segments (Fig. 3, W). It is then taken and kneaded by the mandibles, and moistened with saliva, until sufficiently soft and sticky for use.

Pollen is carried on the hind legs. With the last joint of its hind legs, on the outer surface of which are several rows of stiff hairs (Fig. 4, B), the bee brushes the pollen from its body. The collected pollen is then transferred to the pollen basket (Fig. 4, PB), a depression on the inner side of the tibia (T) of the opposite leg. (In Fig. 4, F is the femur, C the claws with which the bee clings to flowers, etc., and *f* constitutes the foot.)

The bee community consists of the Queen (Fig. 2), the workers (Fig. 1), and the drones, the latter being males, while the workers are infertile females or neuters. The fertilised queen deposits her eggs one to a cell, where they pass through the stages of grub (Figs. 7, 8 and 9), pupa (Fig. 10), and perfect insect.


THE HONEY-BEE.
1
2
3
W
F
PB
T
B
f
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C
5
SE
CE
BJ
A
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XXVII. THE BUTTERFLY

THE four delicate wings of the Butterfly (Fig. 1) are covered with tiny powdery scales (Fig. 2) which are so easily dislodged as to render it difficult to handle the insect without spoiling its wings. For this reason Butterflies, together with Moths, are called " scale-winged " insects (*Lepidoptera*).

To its large, compound eyes the Butterfly owes its wide range of vision, and to its large antennæ its keen senses of smell and touch. In the Butterfly these antennæ are clubbed (Fig. 3); while in the Moth they are not clubbed but plumy, this giving increased keenness of smell, as befits a night-flying insect, as most Moths are.

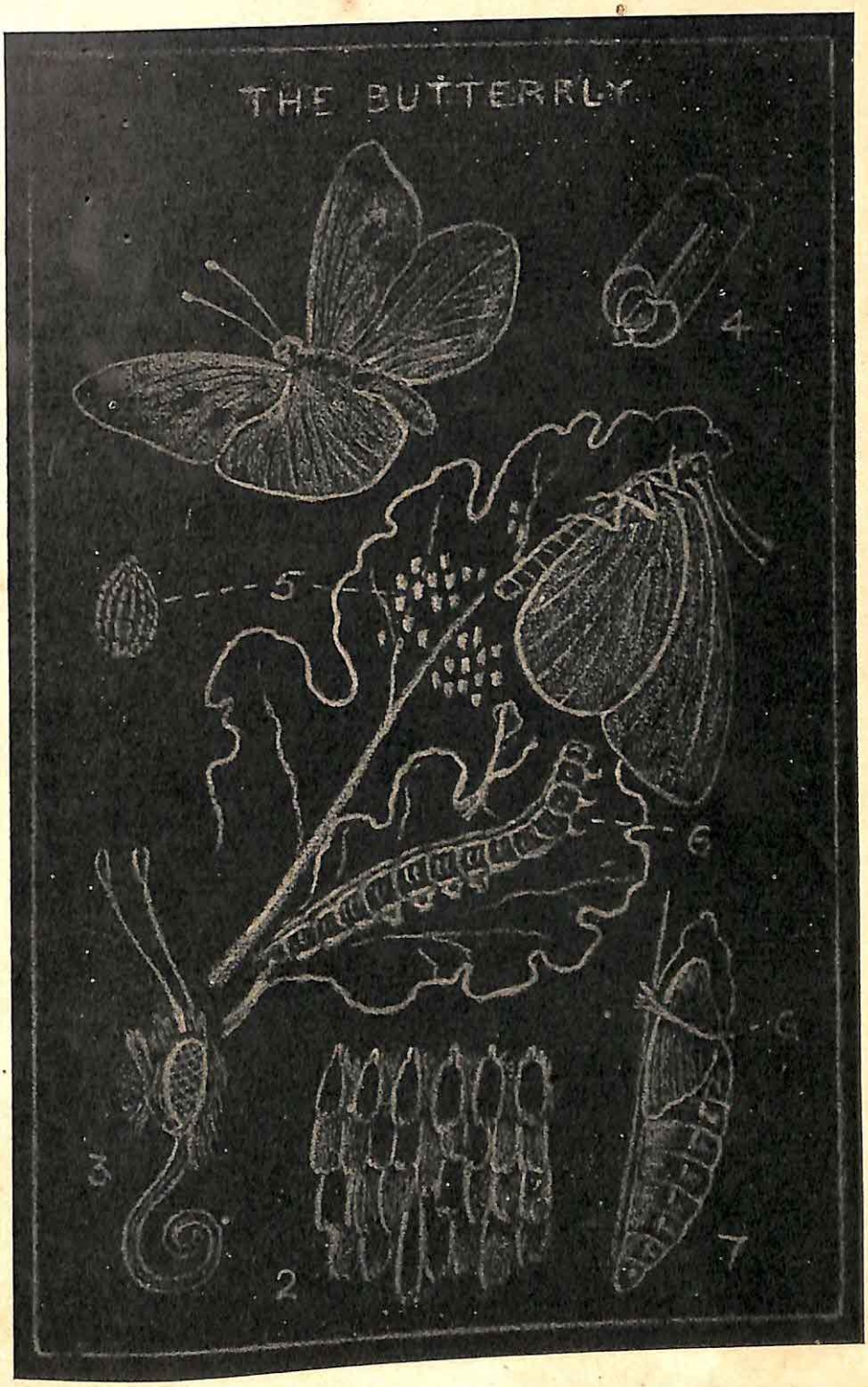
The food of the Butterfly is nectar, which it sucks from flowers by means of its long tongue or proboscis (Fig. 3—head of Butterfly), which is carried curled up when not in use. This proboscis is formed of two separate crescent-shaped tubes, each grooved on the side facing the other, so that when brought closely together they form a median tube. (Fig. 4, portion of proboscis.) It is up this median tube that the nectar passes, the two other tubes, filled with air, aiding (probably) in the work of suction.

On an appropriate food-plant the female deposits her eggs (Fig. 6, Cabbage Butterfly), the surface of which in many cases is beautifully sculptured (Fig. 5). From the egg emerges the grub or caterpillar (Fig. 6), armed with biting jaws and gifted with an insatiable appetite.

There are three pairs of fore-legs, each ending in a hook, and answering to the six legs of the perfect insect. Separated from these by an interval are the soft, fleshy hind-legs, each ending in a fleshy pad edged with a row of small claws, and capable of being lengthened or shortened at will. These are the " claspers " with which the creature clings to the food plant when eating, and which also aid the caterpillar in walking.

Rapid growth, made possible by a succession of changes of the inelastic skin, leads to the chrysalis stage (Fig. 7). In the Cabbage Butterfly, among others, the caterpillar before changing fastens itself to some support by means of a silk sling or girdle (Fig. 7, G), and thus secured passes its pupal stage, until from the dry, dead-looking case emerges the perfect insect (Fig. 1).

It is interesting to note that the Cabbage Butterfly is the only butterfly that does harm to cultivated plants, whereas among the moths are many of the most destructive of garden and field pests.


THE BUTTERFLY
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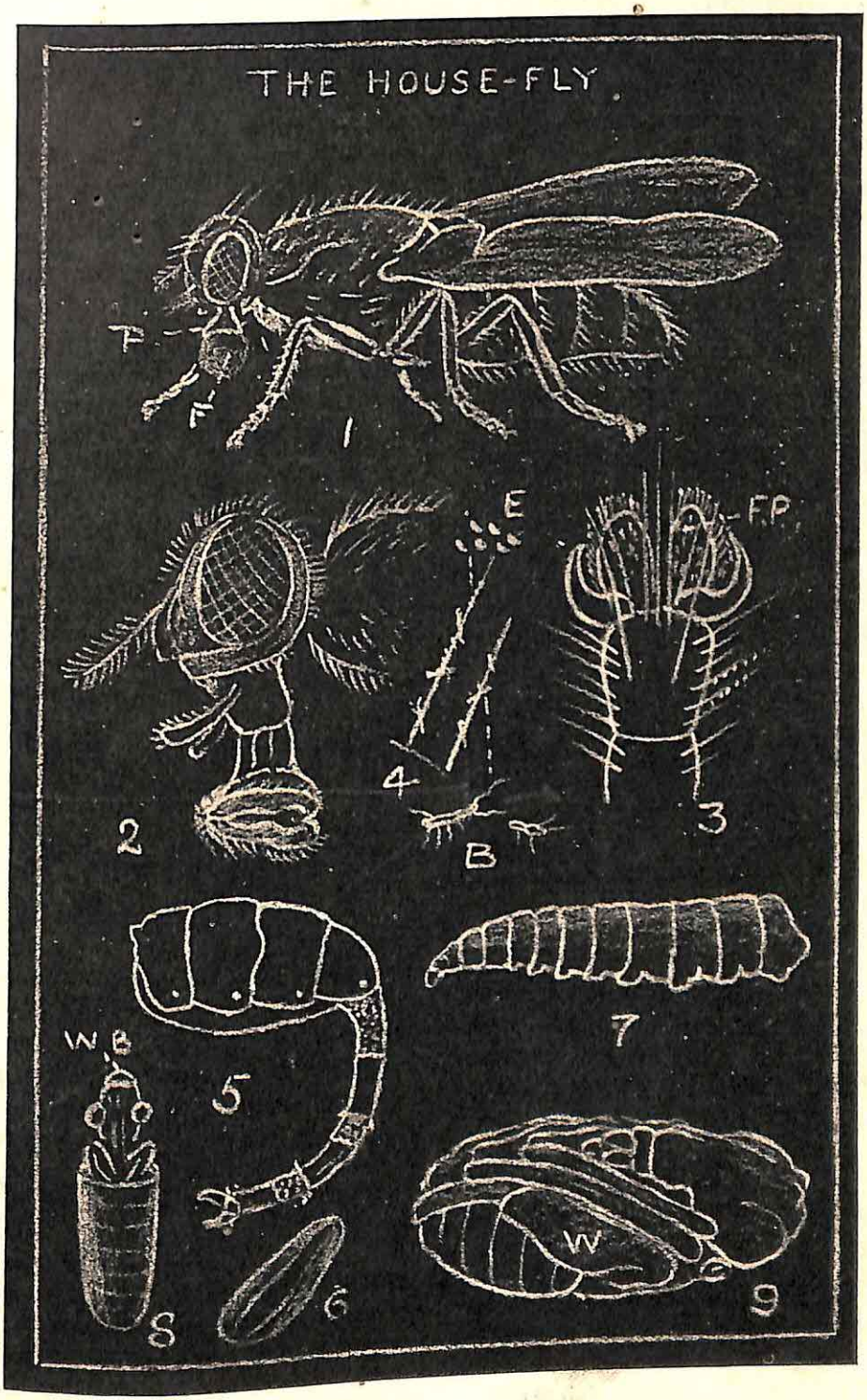
XXVIII. THE HOUSE-FLY

THE House-Fly (Fig. 1) agrees with all other true flies in possessing but one pair of wings : hence the group name *Diptera*, *i.e.*, "two-winged insects." In place of a second pair of wings there are two rod-like bodies commonly regarded as *balancers*, very small in the House-Fly, but quite large in the Crane-Fly (*vide* Lesson XXIX.) and the Dragon-Fly. The chief organs of sense are the compound and single eyes, and the antennæ (Figs. 1 and 2), the latter being feathery.

The tongue or proboscis (Fig. 1, P, and Fig. 2) terminates in two large lobes which can be opened and closed at will. When the tongue is pressed down on to the surface of food, such as sugar, saliva is poured out from the mouth, and then sucked up again with some of the food in solution. Round the mouth are the fly's "teeth," a number of forked rods used for rasping the surface of the food, and thus exposing a fresh surface to the action of the sucker. Sometimes the food is "brought up" again, and reappears at the end of the proboscis as a spherical drop (Fig. 1, F) which is generally reabsorbed. The germs (*bacilli*) of a number of diseases taken in with the food may be thus disgorged and deposited on human food or elsewhere in such a way as to spread the disease ; while other deadly germs are carried on the hairs of the body or of the feet. (Fig. 3, foot of fly with two infected hairs. Fig. 4, infected hairs greatly enlarged, E and B being two forms of bacteria.) Hence the great need of destroying house-flies by all possible means. The best method is to prevent the fly from breeding, which it does by depositing its eggs on rubbish and manure heaps. Such heaps should not be allowed to accumulate ; and methods should be adopted for destroying the eggs when laid. By means of a long egg-layer (*ovipositor*, Fig. 5) the female fly deposits her eggs (Fig. 6) a little way below the surface of the manure heap, where they quickly hatch out into white grubs, which when mature (Fig. 7) crawl into some sheltered spot where they change colour and turn into pupæ (Fig. 9, pupa with tough case removed). After three or four days the perfect fly is ready to emerge, and it makes its escape in a very remarkable manner. Its head is furnished with a little water-bag (Fig. 8, WB) and with this it presses upon the end of the pupal case which yields and allows the fly to escape.

Each of the six feet is provided with a pair of pads (Fig. 3, FP—foot-pads) beset with viscid hairs, which enable the fly to walk securely on such smooth vertical surfaces as a window pane or "upside-down" on a ceiling. On a rough surface the pads are not required, and are drawn in between the claws on which the fly then walks.


THE HOUSE-FLY
P
F
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E
FP
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B
WB
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7
8
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XXIX. APHIS AND LADYBIRD

PLANT Lice, Blight, Green Fly, or Aphides (Figs. 1—10), as they are variously called, are among the most widely-spread and most terribly destructive of insect pests. (Figs. 1, 2—Woolly Aphis ; 7, 8—Cabbage Aphis ; 9, 10—Turnip Aphis.) They differ from all other insects in the form of the mouth, which consists of a beak with which they are able to pierce the tissues of plants and suck the juices therefrom. (Fig. 5—Wingless Aphis, and Fig. 6—Winged Aphis, show this beak clearly.) The abdomen often bears a sharp or curved tip near which are usually, but not always, two horn-like hollow tubes from which exudes a sticky fluid, quite distinct from the sugary fluid, known as honey dew, which is discharged from the intestines.

From the attacks of one or more of the numerous species of Green Fly many of our garden and field crops (such as Cabbage and Turnip) and our fruit trees suffer, the special pest of the Apple being known as the Woolly Blight by reason of the creature exuding a kind of cotton wool (Fig. 1), which, like the plume of the Dandelion fruit, forms a means of migration ; and thus the blight spreads. The male is winged, but the female may be either winged or wingless ; and they may produce young alive, or they may lay eggs as the majority of insects do.

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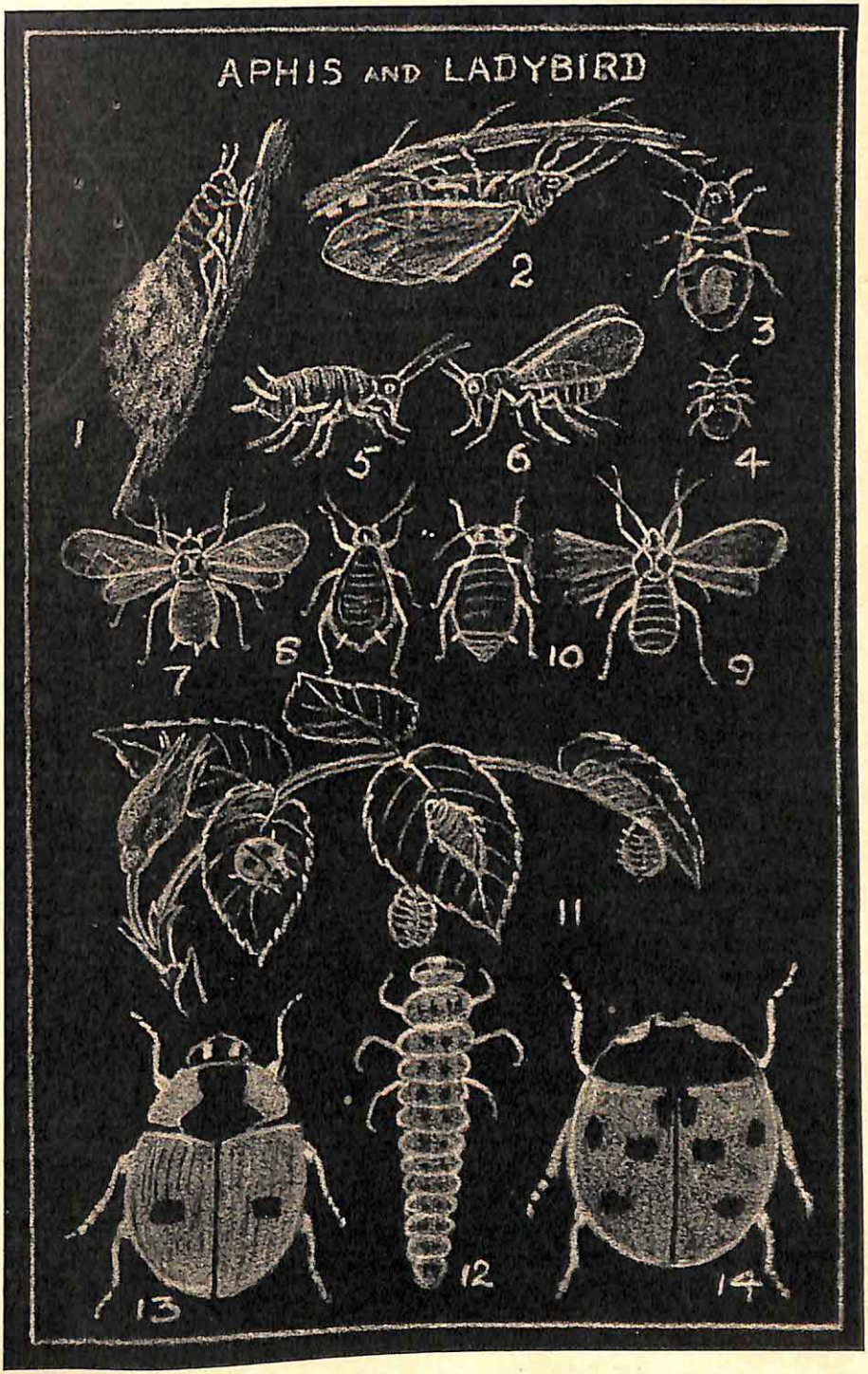
Among the destroyers of Plant Lice is the Ladybird, a pretty little beetle with red or yellow wing-cases spotted with black. (Fig. 13—Two-spotted Ladybird ; Fig. 14—Seven-spotted Ladybird.) They lay their yellow eggs in clusters upon plants infested with Plant Lice, upon which the grubs greedily feed. The grub is a very slow-moving creature, creeping on its six legs, and aided by the tip of its tapering body, which can be shortened or lengthened at will, and thus used to push the body along. Luckily for us these grubs have an insatiable appetite, and devour the Green Fly in large numbers, meeting with no resistance from their victims, which are affixed to the plant by their beaks. When full-fed the grub settles upon a leaf (Fig. 11) to which it glues itself by a sticky fluid ; and, hanging by its tail, changes into a pupa.

The beetle itself, which flies well but creeps slowly, continues the good work of devouring the Green Fly ; and when the latter abounds the Ladybird is comparatively plentiful, producing two or three broods in a single season. When alarmed the beetle tucks in its legs, and gives out from the joints a yellow fluid with an unpleasant taste and smell ; the grubs also being able to give out a similar protective fluid.


APHIS AND LADYBIRD
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XXX. THE CRANE FLY AND CLICK BEETLE

THE Crane Fly (Fig. 1) or Daddy-long-legs may be seen drifting about on its two gauzy wings just above the meadow grass in August or September. The long stilt-like legs enable the fly to walk more easily over the blades of grass; and they also enable the female to hold her long body erect and, using it as a boring-tool, make a small hole in the ground wherein she lays a single egg, and this she does some 300 times until her supply of eggs is exhausted.

The wrinkled, dirty-brown, worm-like, legless grubs (Fig. 2) are so tough of skin that they are called *leather-jackets*. They bore their way through the soil, feeding hungrily upon the roots of corn, grass, and other plants; and when numerous the damage they do is enormous. The mischief usually begins about May, or even earlier in warm seasons, and as a rule the grub is full-grown by the end of June. Then it changes into a pupa (Fig. 3), the hinder end of whose body is armed with a number of bristles which enable it to push its way upwards until the front half of its body stands clear above the surface. The tough skin then splits down the back and the perfect insect makes its escape.

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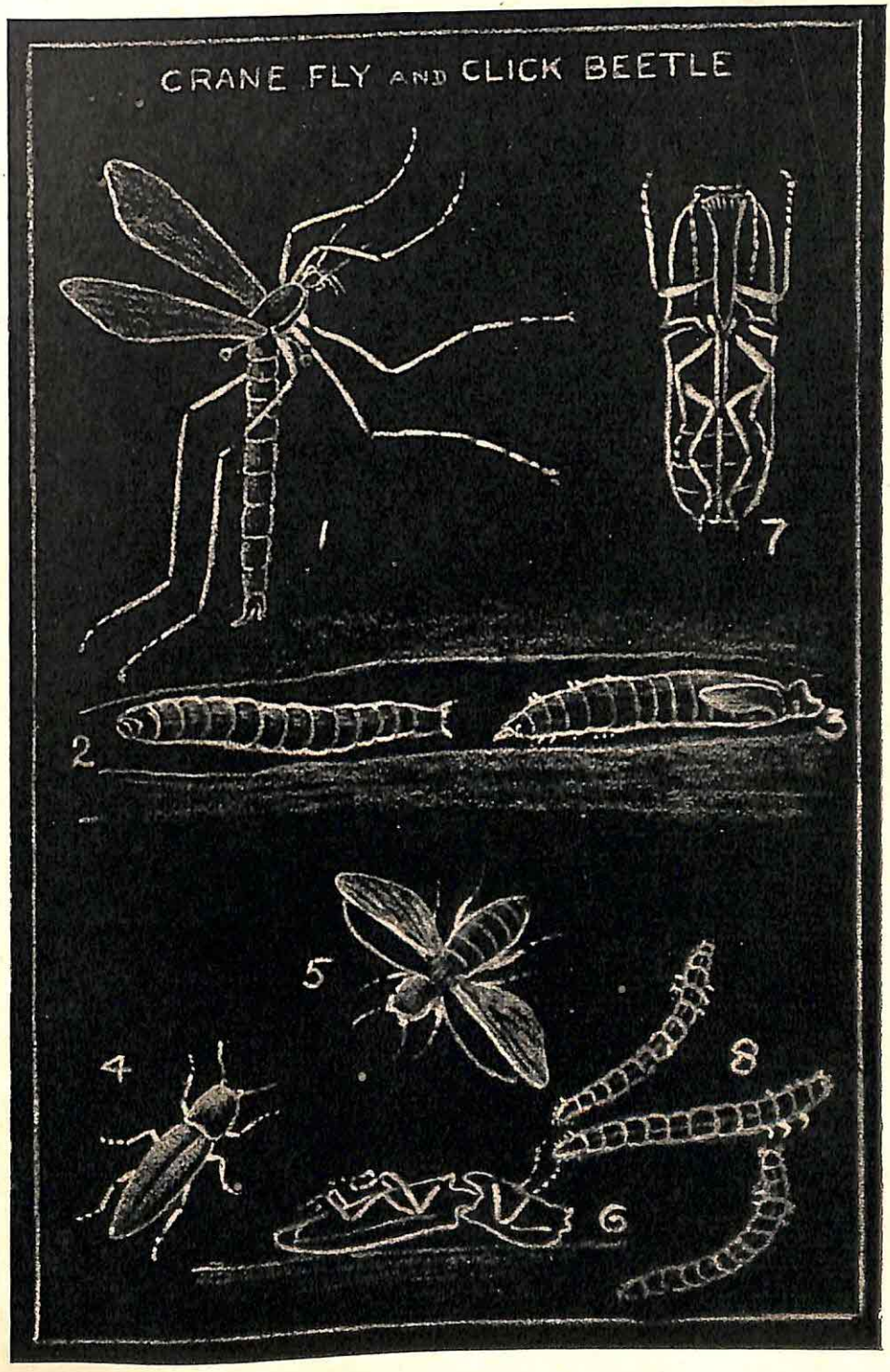
Another serious insect pest is the Wireworm (Fig. 8), the grub of a small beetle, popularly known as the *Click Beetle* or Skipjack (Figs. 4 and 5). The grub gets its name from its slender body and exceedingly tough skin, which however fails to save it from the Mole, Rook, Starling, Lapwing and Pheasant, which also wage war upon the Leather-jacket, greatly to the benefit of mankind. For three years the Wireworm lives underground and continues its ravages; then in July or August of the third year, being full-grown, it makes an oval cocoon within which it spends two or three weeks as a pupa, although the perfect insect may not escape until spring.

Should the beetle fall upon its back it rights itself by springing into the air with a click, to which the name is due. On the under side of the body (Figs. 6 and 7) a strong spine may be seen where the body is jointed,* this spine locking into a cavity on the next segment. Considerable force has to be exerted to effect this, the spine enters the socket with a click, the body is bent, the wing-covers strike the ground sharply and the beetle is jerked into the air, and after, say, two or three attempts the beetle succeeds in turning itself "right side up."

* Note that this "joint" in the beetle is not the dividing line between the thorax and the abdomen, but divides the thorax into two parts.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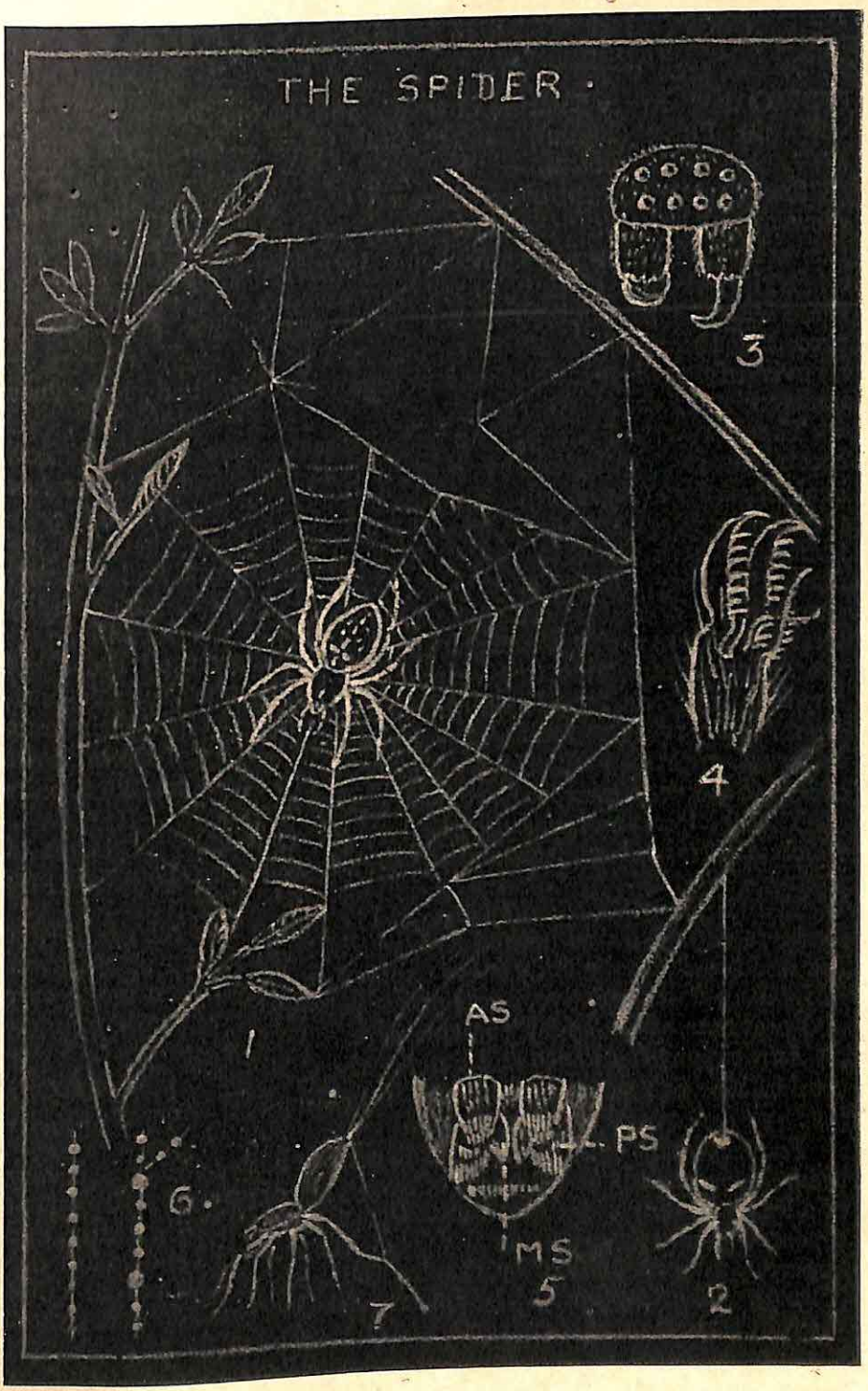
XXXI. THE SPIDER

THE Spider (Fig. 1) is not an insect, from which it differs in many respects. The head and chest are fused together into one piece, there are eight legs, the body does not consist of rings or segments, and when they hatch out of the eggs the young spiders resemble their parents : there is no grub or pupa stage for them to pass through. Then, too, the spider breathes by means of "lung-books," two little slits in the abdomen near the waist-line (Fig. 2) opening into pockets through whose delicate folds the blood flows to be purified.

The Spider is fully fitted for its life as a "beast of prey." In many cases its prey is snared by means of a net of fine silk ; and it is armed with a pair of powerful, poison-fangs, which when not in use can be folded away in a groove, like the blade of a pocket knife (Fig. 3, head of Spider, showing eight simple eyes and fangs, one of which is folded). The eyes are placed well forwards, as is often the case with hunting animals. Having killed its victim the Spider proceeds to suck out the juices of the body ; or, rejecting such dry parts as the wings, it proceeds to cut up the body into tiny pieces which are sucked into the mouth.

Within the large abdomen are glands that secrete a fluid which, when pressed out through the fine tubes that go to form the *spinnerets*, sets into fine but very strong threads (Fig. 5, AS—anterior spinnerets ; PS—posterior spinnerets ; MS—median spinnerets of the Garden Spider). With such threads spiders lower themselves from a support (Fig. 2), line their hiding-places, make egg cocoons, or weave snares of various forms, the web of the Garden Spider (Fig. 1) being but one of many. Of the threads composing this web there are two distinct kinds serving two distinct purposes ; dry ones forming the framework and the central part of the web where the Spider rests, and viscid ones forming the greater part of the spiral strands. These latter are covered with tiny globules of viscid matter (Fig. 6) secreted by distinct glands ; and they constitute the effective part of the trap. In the weaving of its web the Spider makes great use of its claws (Fig. 4), which it uses almost as we use our hands in pulling taut each thread before fixing it.

With similar silk the House Spider weaves its sheet-like web ; the Water Spider makes its bell-shaped home moored to the water-weeds ; and the Hunting Spider makes its life-line with which it secures itself from falling when it leaps upon its victim on a wall or other vertical surface. And with its fine gossamer plumes the young spider launches itself forth in the world, migrating to prevent overcrowding. (Fig. 7, young spider, with abdomen raised, giving forth silk threads that act like the plume of a dandelion fruit.)


THE SPIDER.
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XXXII. SOME CRUSTACEA

TO the " crusty " nature of their coats the Sandhopper (Fig. 1), the Prawn (Fig. 2), and the Crab (Fig. 3) owe their family name of *Crustacea*.

Sandhoppers swarm everywhere on the damp sand of the seashore of which they are the scavengers. As the sand dries they bury themselves, their proper home being just above high-water level. Of the legs the last three pairs are turned backwards, and it is with these that the Sandhopper makes its leaps, the three pairs of legs preceding these being used in swimming when needed. (Owing to an oversight the legs of the first four segments of the body have been omitted in the drawing.)

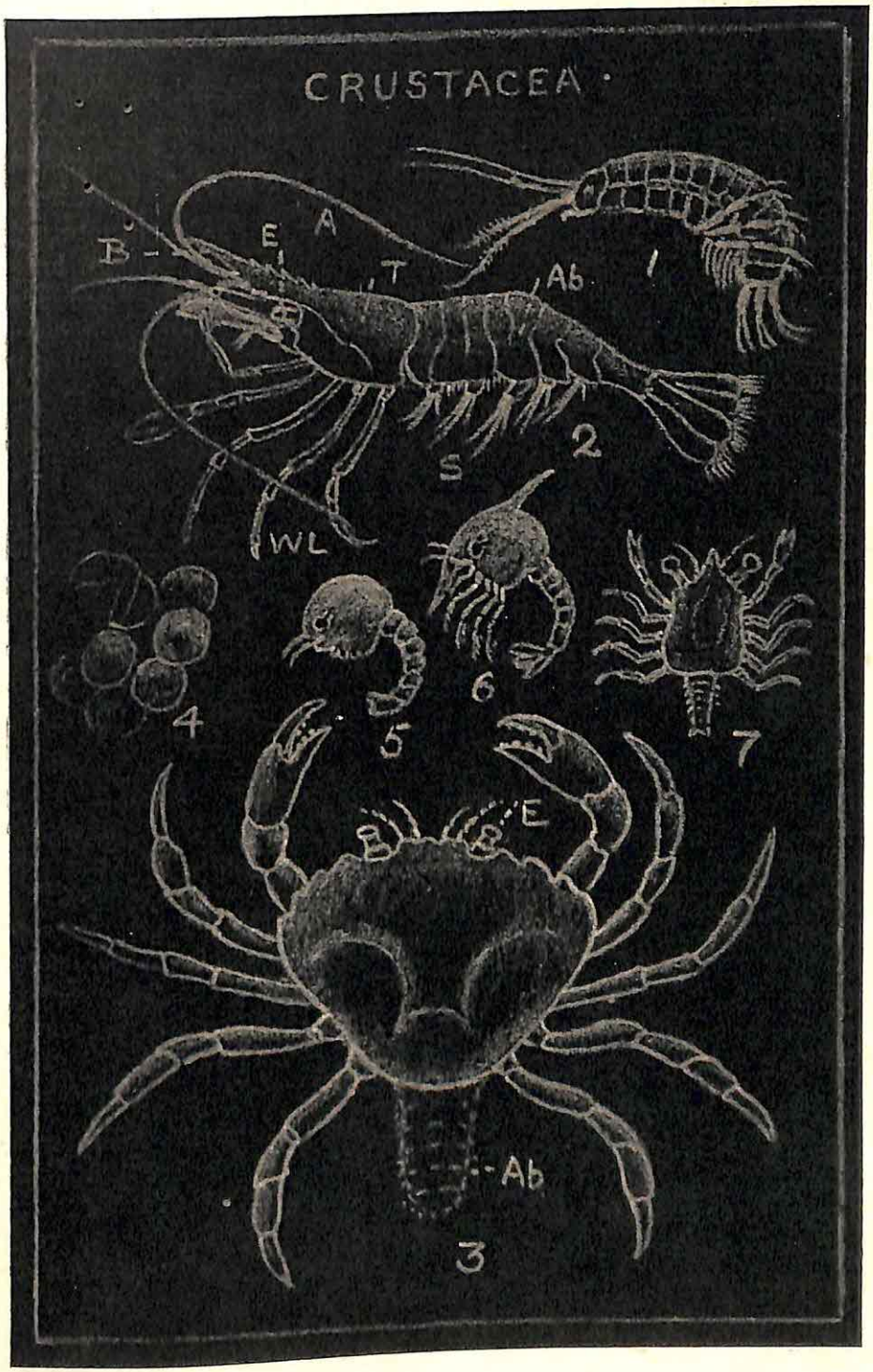
The Prawn and the Shrimp are the scavengers of the shallow coastal waters, the former being easily distinguished by its toothed beak or *rostrum* (Fig. 2, B). They belong to the " long-tailed " crustacea, as distinguished from the " short-tailed " members of the family, such as the Crab, which keeps its short tail tucked away under its body. (In Fig. 3 this short tail is shown unnaturally extended.) The one-piece shield (Fig. 2, thorax) overlaps and protects the gills and other important organs ; whereas the " crust " of the abdomen is jointed to give free play to the muscles, this part, together with the fan-like tailpiece, forming the chief swimming organ. At each forward stroke of the spread fan the Prawn darts *backwards* through the water ; while by means of the five hind pairs of legs (S=swimmerets) it rows itself gently *forwards*.

The chief sense organs are the long antennæ (A)—by means of which the Prawn both feels and smells—and the eyes (E) set on projecting eye-stalks.

The *Common Shore Crab* (Fig. 3), like most of its relatives, runs swiftly sideways on its jointed legs, which, being set far apart, leave the under side of the body more exposed to attack than is the case in its long-tailed relative, the Lobster : hence the greater firmness and hardness of its " coat " in this part.

As weapons of offence and defence the Crab has a pair of strong toothed claws or pincers, used both in fighting and in capturing and tearing to pieces its prey.

From the eggs (Fig. 4) of the Crab emerge curious creatures, very unlike their parents (Figs. 5 and 6, two stages of growth). By means of a long tail they swim about near the surface, feeding greedily, and repeatedly changing their coat. Then the strange head-spines disappear, and gradually they assume the form of the parent crabs (Fig. 7). Thereafter with their short, feeble tail tucked under them they, in most cases, become crawlers on the bed of the sea.


CRUSTACEA
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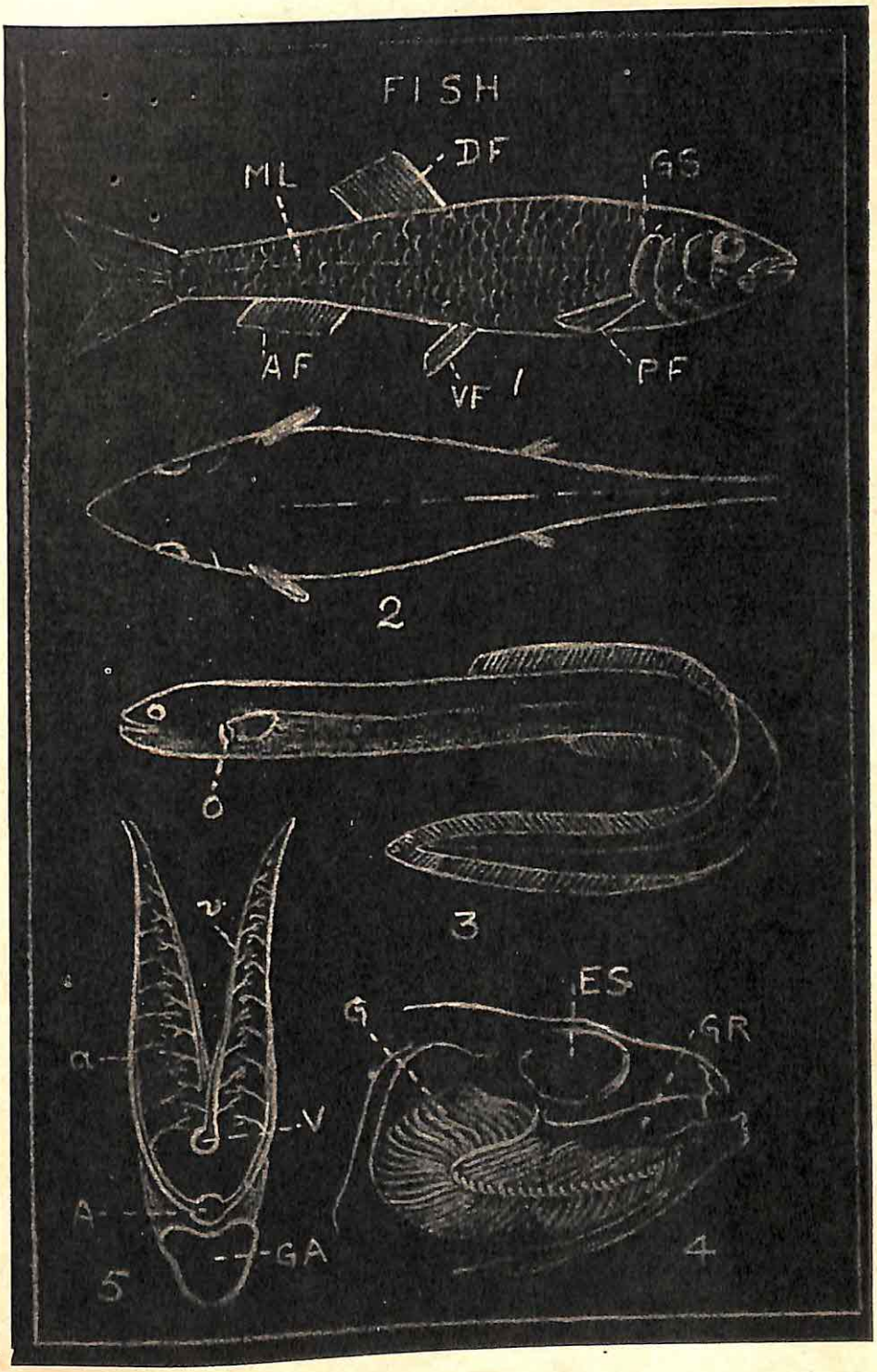
XXXIII. THE FISH

A TYPICAL fish (Fig. 1) is adapted in every detail for a life in the water. Its shape tapering in both directions from near the gill openings, is such that its passage through the water is rendered as easy as possible. (Fig. 1, typical fish viewed from the side; Fig. 2, viewed from above.) There are no projecting shoulders or limbs; and such is its form that behind the long tapering body there is no " backwash " to act as a brake and reduce speed. Added to all this are the close-fitting coat of scales, and the slippery mucus with which this smooth coat is kept well " oiled." (Hence the saying, " As slippery as a fish.")

The chief means of locomotion is the muscular tail-end of the body with its fan-like fin; the other fins, especially the dorsal fin (DF), the anal fin (AF) and the ventral fin (VF), being chiefly useful as balances and cut-waters. In some fish progress is made by throwing the body into curves, which press upon the water as they straighten out, this being the case with such elongated forms as the Eel (Fig. 3) or flat-fish such as the Sole. In both cases the fins play an *active* part in locomotion by rendering the body broader and therefore giving it a greater " purchase " on the water, the fins often forming a fringe along the greater portion of the body.

The fish breathes by taking in water at the mouth and passing it out at the gill slits (Fig. 1, GS) after it has passed over the gills through which the blood circulates. (Fig. 5 shows a small portion of a gill. GA=gill arch; A=artery; V=vein. In Fig. 4, G=gills; GR=horny gill rakers, which protect the tender gills from injury by hard bodies which may enter the mouth with the water; ES=eye socket.) In the Eel the gill slits are closed except for a small opening (Fig. 2, O=operculum). Hence the Eel is able to live out of water for a considerable time, its gills remaining moist and unshrunk, and the blood being able to course through them.

Fish have no movable, opaque eyelids with which to shut out light, a fact to be borne in mind by those who keep gold fish in glass bowls. The senses of hearing and smell are not very acute, nor is the sense of touch; but the fish is able to receive impressions from the outer world by means of a special set of sense organs—a series of tiny slime-filled pits in which a large number of fine nerves find an ending. These pits are arranged in a line along the sides. (Fig. 1, ML=median line.)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XXXIV. THE FROG

THE Frog (Fig. 10) belongs to a lowly class of animals called *Amphibia* because they are fitted for a life spent partly on land and partly in water. It is not a reptile, from which it differs in many respects, such as the absence of ribs, the thin moist skin, and a very different life-history.

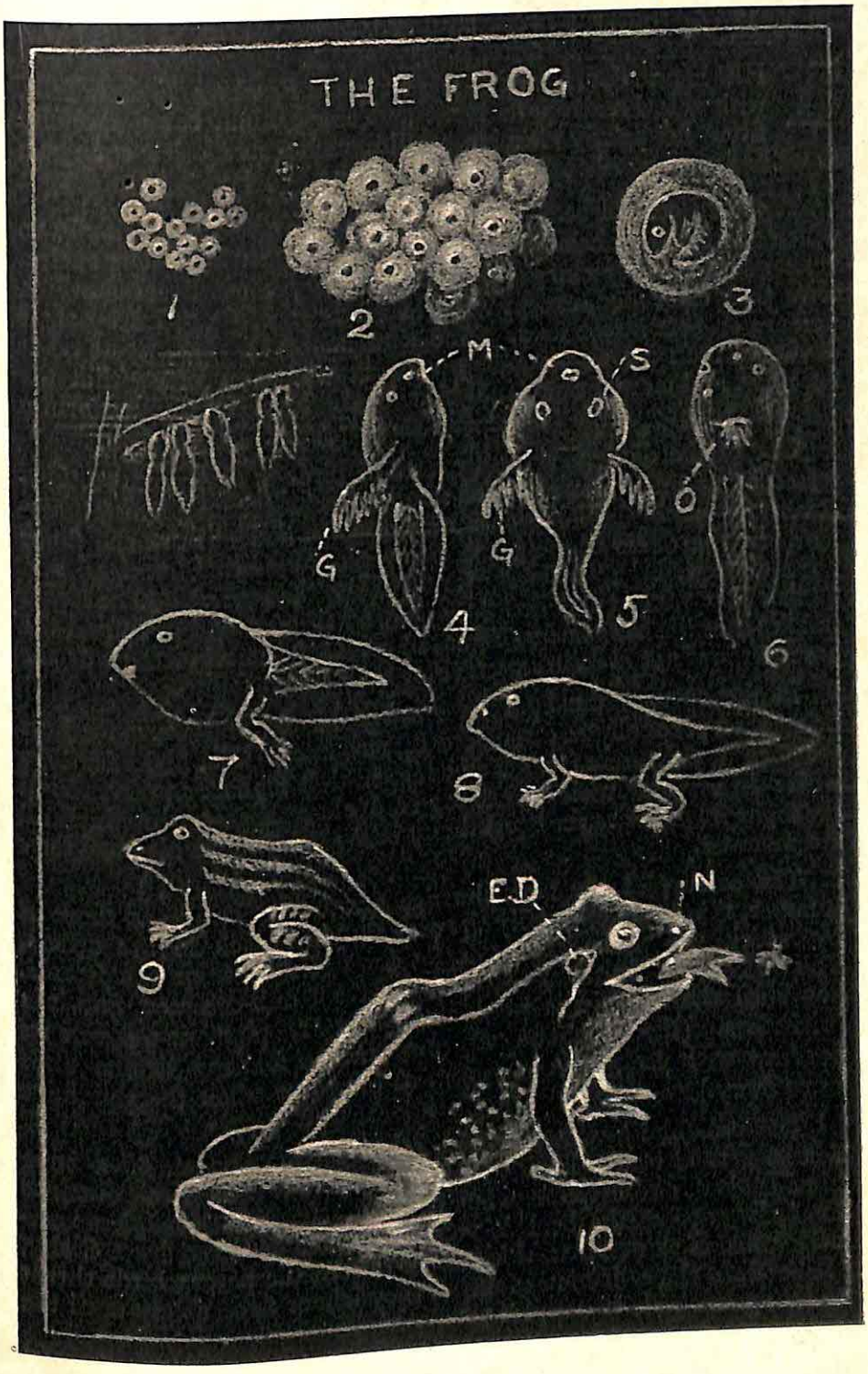
During March and April the eggs (Fig. 1) are laid in shallow water, and soon swelling up form the familiar frog-spawn (Fig. 2). Floating near the surface of the water, the black specks, set in the midst of a mass of clear jelly absorb the warmth of the spring sun and develop into little black creatures (Fig. 3), which eventually escape as young Tadpoles, differing in almost every respect from their parents.

By means of a pair of suckers the young Tadpole clings to weeds or other objects in the water (Unnumbered Fig.), requiring no food until the egg-food stored up in its body is used up. At a little later stage (Fig. 4, side view; Fig. 5, view from below) the Tadpole possesses a horny mouth (M), suckers (S), feathery gills (G), and a flattened tail; in all these respects being more like a fish than a frog. Soon the external gills shrink and are replaced by others almost entirely covered in by a fold of skin (Fig. 6), an opening being left on one side so that water taken in at the mouth passes over the gills and out at this opening.

Other changes gradually take place: the tail shrinks; legs appear, first the hind legs (Fig. 7) and then the front legs (Fig. 8); the gills are absorbed and lungs develop, fitting the young frog for a life on the land. The mouth grows large (Fig. 9), teeth and a tongue develop, the skeleton hardens, until, behold, the perfect frog (Fig. 10), which, by means of its powerful hind legs, leaps on land or swims in the water.

The senses of sight and hearing (Fig. 10, E D=ear drum) are well developed, vision being given in all directions by the prominent eyes, which can be depressed at will. The tongue is forked and viscid, and, the root being at the front of the mouth, it can be shot forth rapidly (Fig. 10) and used to capture small creatures which are swallowed whole. The tiny teeth are quite useless for purpose of mastication, but are of use for holding such captured prey as worms.

Being ribless and without a *diaphragm* (the partition between the thorax and the abdomen) the frog breathes by tightly closing its mouth, drawing in air at the nostrils (Fig. 10, N) by depressing the floor of the capacious mouth, then closing the nostrils, and forcing the air into the lungs by raising the floor of the mouth. In brief, the frog breathes by forcibly pumping air into its lungs.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XXXV. THE HOUSE SPARROW

THE House Sparrow (Fig. 1) is a typical *Perching Bird*, its foot, with the three toes in front and one behind, being specially fitted for lightly clasping small branches and other supports, as well as resting or hopping on the ground.

The hard conical beak is equally typical of the *Finch family* to which the Sparrow belongs ; all the members of which have such a beak adapted for picking up and cracking the small seeds which form their chief food, except when as nestlings they are fed by their parents on soft insect food. And since many of the insects thus devoured are noxious pests, it is when rearing their young that the Sparrow, and many other small birds of the Finch family, perform a valuable service to the farmer and the gardener.

One of the distinguishing features of birds is the plumage, possessed by no other animal. The smaller feathers form a warm body-covering ; while the large ones of the wings and tail are the flight feathers, the quills of the wings being the " rowers " (*remiges*) and those of the tail the " steerers " or " rudder " (*rectrices*). [The larger quills of the wings are called the *primaries* (Figs. 1 and 2, P) and the smaller ones the *secondaries* (Fig. 2, S), while the small feathers at the base of the wings are the *coverts* (Fig. 1, C).]

In the autumn the Sparrow *moults*, the old and worn feathers being shed gradually and replaced by new ones. The flight feathers are shed in pairs, one from each wing, so that flight is not interfered with ; in contrast with such birds as ducks and geese, in which all the flight feathers are shed together, and flight is impossible until they are renewed.

The colours of the new plumage are not so bright as those of summer, this being especially the case with the black throat feathers, by which the male bird is easily distinguished from the female. This is because the tip of the new feathers is dull-coloured, and it is not until the dull tip is worn away that the plumage recovers its brightness. (Fig. 3 shows the new throat feathers of the male Sparrow with the grey tips ; Fig. 4, the same when the tips have worn away.)

The pale bluish-white, spotted eggs (Fig. 5) are laid in a snug domed nest of straw, lined with feathers ; and they hatch out into blind, naked, and helpless young (Fig. 6). In all such helpless nestlings the gape of the beak is very wide, and bordered by a fleshy, yellow fold of skin. Into this gaping cavern the parent birds thrust the food, in the collection of which they labour unceasingly until the fledglings are able to support themselves.


THE SPARROW
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XXXVI. THE OWL

THE typical Owl, such as the Barn Owl (Fig. 1), is a nocturnal bird of prey, although some species, such as the Short-eared Owl, often hunt their prey by day. Owls are distinguished by the upright position in which they hold themselves, the full, round eyes that look one full in the face, the concentric bands of small feathers surrounding the eyes, the soft fluffy plumage, the sharp curved beak, and long sharp claws.

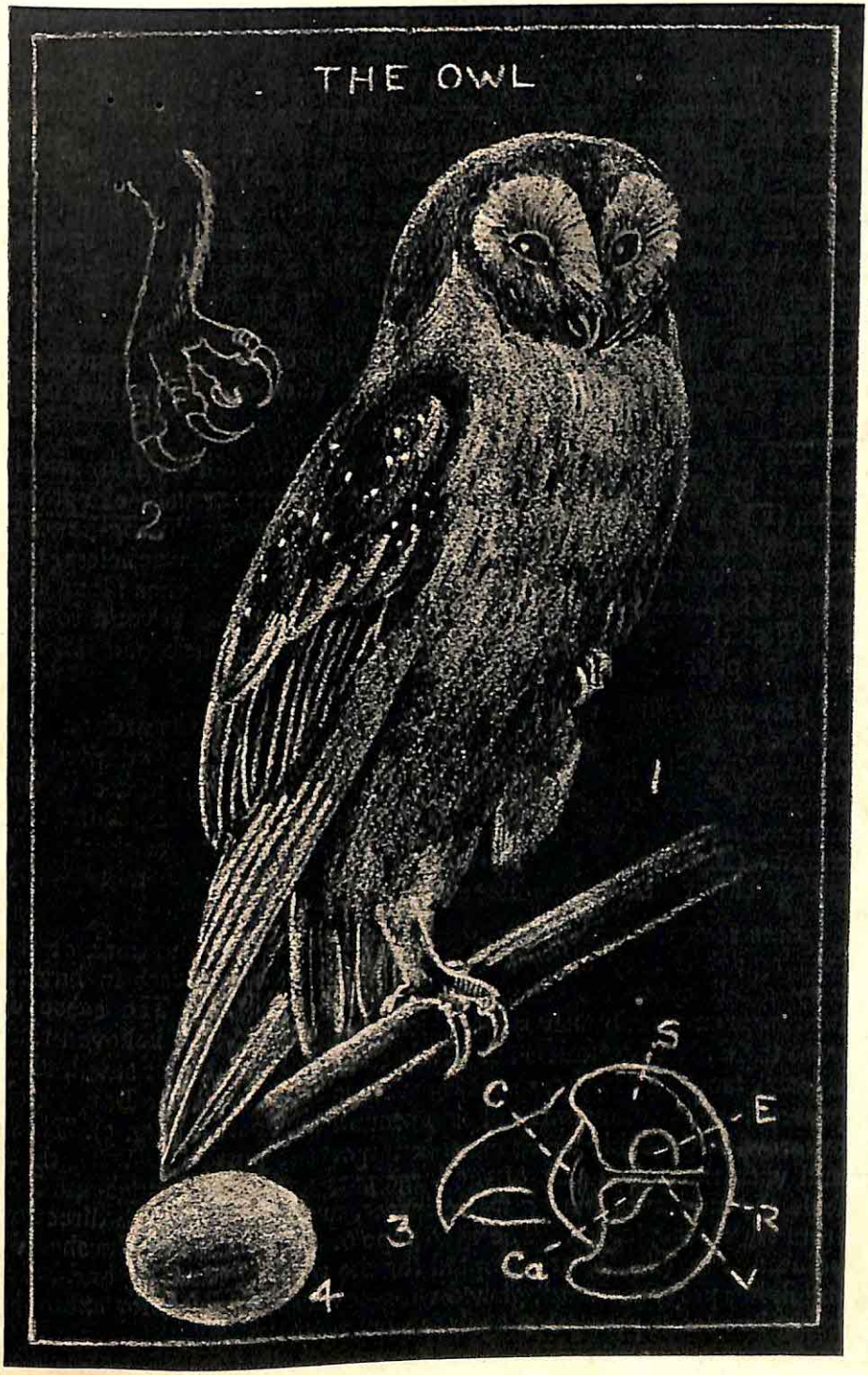
The large eyes, characteristic of most nocturnal creatures, give full entrance to the faint light of dusk, but they do not enable the Owl to " see in the dark," if by that is meant seeing without light, that being impossible. Broadly speaking, eyes set well forward like those of the owl are characteristic of " hunters," whereas eyes set prominently and well back, like those of the Hare, are characteristic of the " hunted " among animals, a wide range of vision being thus secured.

In the Barn Owl and other common British Owls the opening to the ear (Fig. 3, E) is very large and protected by a flap of skin ; and on one side the opening is above the median line (V) while on the other it is below this line, this enabling the bird the better to hear the least noise coming from above or below. (In Fig. 3, S=skull ; E=ear ; C=cover, slit up to form a concentric opening, of which R is the rim ; V=valve or pulley of skin by which the ear-cover is pulled back over the skull to meet the rim ; Ca=cave or hollow other than the actual opening of the ear.) The term " ear " in the names " Long-eared " and " Short-eared " applied to Owls refers to tufts of feathers which look like external ears.

The soft, fluffy nature of the feathers gives a very deceptive appearance of size to the Owl ; but the chief value of such plumage is to secure a noiseless flight ; and, by reason of the large amount of air entangled therein, to form a very warm coat.

The Owl captures its prey with its long, sharp claws (Fig. 2), the power of turning the third toe either backwards or forwards being very helpful in this connection.

The roundish white eggs (Fig. 4) are laid in some out-of-the-way place. Those of the Barn Owl, alone among birds, are laid at such considerable intervals, even while brooding, that in a given nest freshly laid eggs and half-hatched eggs may be found together with young birds.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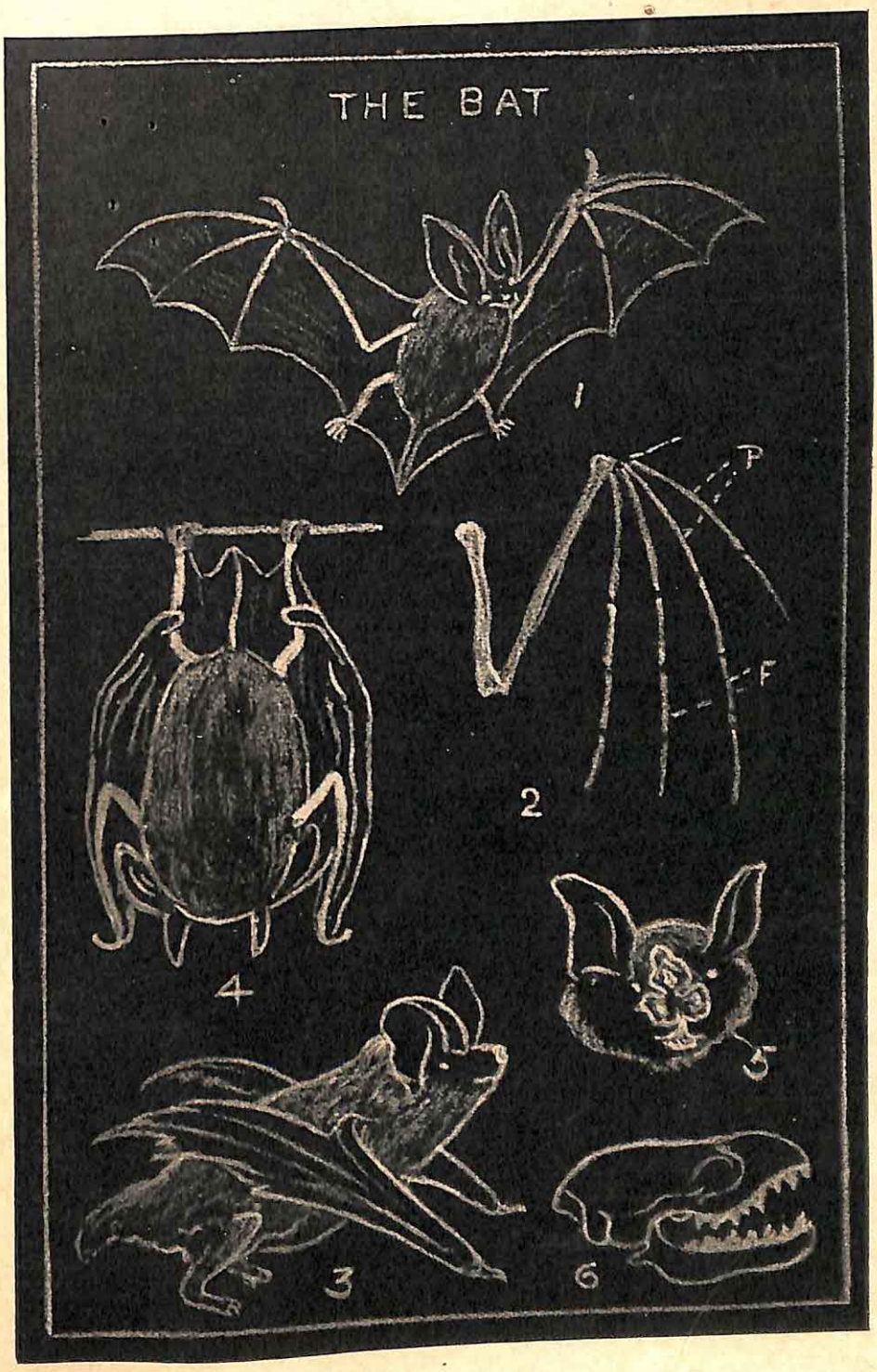
XXXVII. THE BAT

THE name *Bat* originally meant "the flapper"; while the term *Flittermouse* sometimes given to the animal refers to the mouse-like body such as no bird possesses, the Bat being a flying mammal (Fig. 1). The fur is very close and thick, the hairs clinging together to such an extent that no part of the body can be laid bare by a draught of air—a very useful property in an animal that spends the cold season suspended by its hind legs in some out-of-the-way place. (Fig. 4 shows the ordinary sleeping position of the Bat. During hibernation the wings are wrapped like a mantle round the body.) To this matted fur the young bat clings when it accompanies its parent abroad, only one, as a rule, and never more than two, young being produced at a birth.

The wings consists of a tough skin stretched on a bony framework formed by the bones of the arm and of the enormously elongated palm (Fig. 2, P) and fingers (Fig. 2, F), the Bat being a "wing-handed animal," as the family name *Cheiroptera* signifies. Nevertheless, the wing membrane is not confined to the hand, but stretches along the whole length of the body to the hind limbs and even beyond to the tail (Fig. 1). By means of a natural oil the wing-membrane is kept soft and pliable.

However agile on the wing the Bat is very awkward on the ground (Fig. 3), for not only are the fore limbs not well adapted for walking, but the hind limbs are less so, for they are so joined to the body that they can be turned backwards to enable the animal to suspend itself by them. By means of the claws on its short, free thumbs (Figs. 1 and 3) the Bat can climb a tree much more easily and quickly than it can walk on the ground.

Bats seek their prey chiefly after sunset, and in the dusk of the evening; but they differ from most nocturnal creatures in having very small eyes, and correspondingly weak vision. The sense of hearing is extraordinarily keen, so keen indeed that it is believed that even the flight of a moth is audible to them. The sense of smell, also, is keen, especially in those species, such as the Horse-shoe Bat, which possess leaf-like outgrowths of skin around the nostrils (Fig. 5). These outgrowths probably serve another important purpose. With them and with the naked skin of the large ears and of the wings the Bat feels the air-waves from a flying insect, and swoops in the direction from which they come. The wide gape of the mouth and the sharply pointed teeth (Fig. 6) are adapted for the work of catching and holding flying prey, the hard, glazed wing-covers of beetles, for example, being but scant protection against such teeth.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XXXVIII. THE MOLE

THE name *Mole* is a contraction of the A. S. "mould-warp," *i.e.*, the mould-caster or earth-turner ; and in some parts of the country the old name *Mouldiwarp* is still in use. In search of its prey the Mole (Fig. 1) burrows its way through the soil at an astonishing rate, quite apart from its use of the permanent ways or high roads, in making which it casts up the loose heaps of soil known as mole-hills. Still it may be seen in the early morning and evening hunting for food above the surface.

For its subterranean life the Mole is as perfectly fitted as the fish is for a life in the water. The body (Fig. 1) is spindle-shaped, the wedge-shaped head with its pointed gristly snout passing into the body without a break ; there are no external ears ; the fur is soft and velvety, and can be rubbed either way without becoming ruffled, partly because the hairs are thicker in the middle than at either end and partly because they are set more or less vertically in the skin.

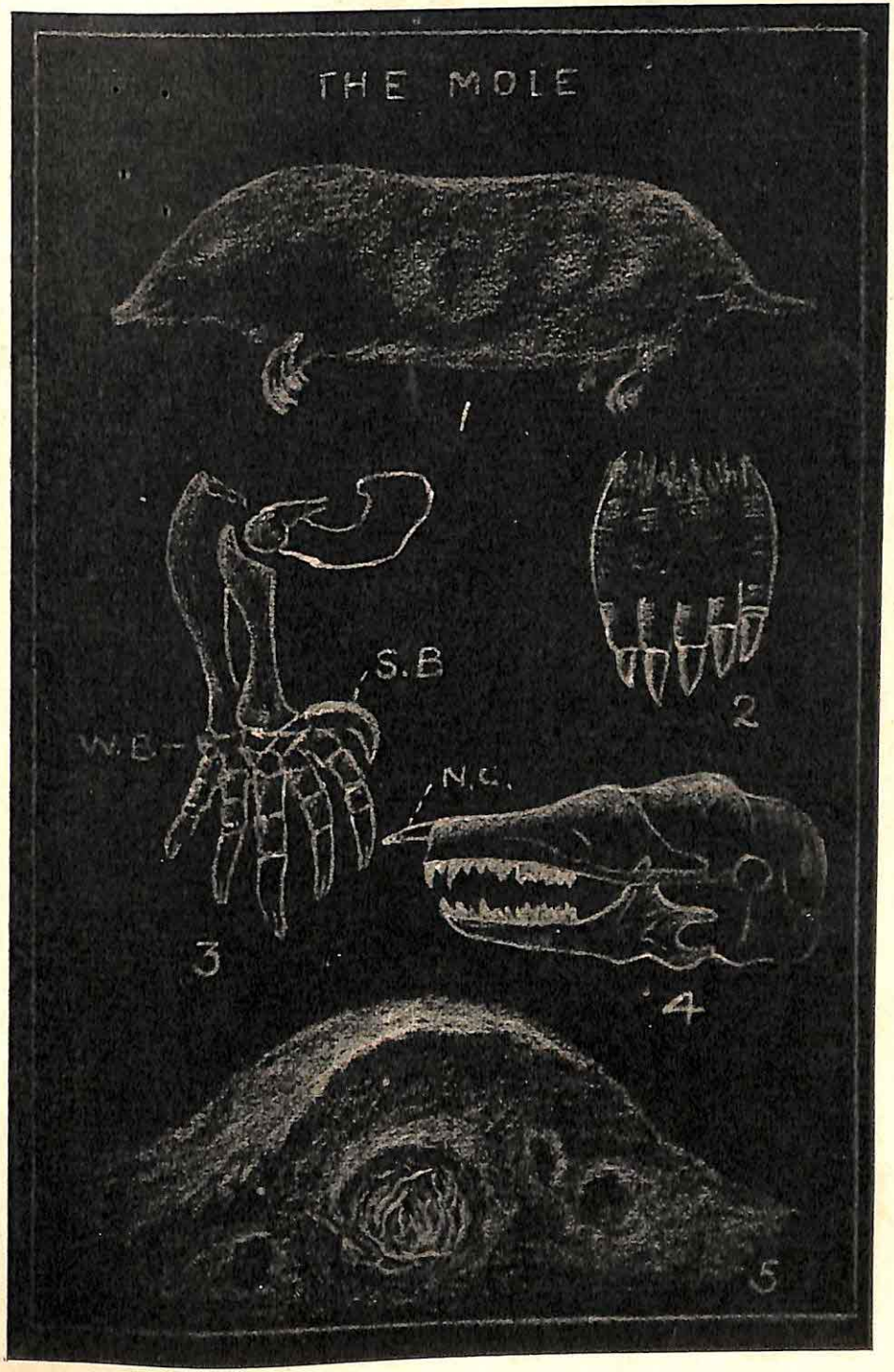
For this reason the Mole can move along its burrows backward without damaging its fur. The eyes are very small and set so deeply in the fur that there is no danger of them being injured by loose soil.

The fore-limbs are short and very powerful, and are buried in the body almost to the wrist. The hand is broad and shovel-like with five strong claws (Fig. 2), to which is added an additional sickle-bone (Fig. 3, S.B.=sickle-bone ; W.B.=wrist bones).

The initial step in burrowing is taken by the gristly snout (Fig. 4, N.C.=nasal cartilage), which is thrust into the soil and moved from side to side before the powerful paddles are brought into play.

The teeth are strong and sharp (Fig. 4), in keeping with the fierce nature and carnivorous habits of the animal. The Mole belongs to the class Insect-eaters (*Insectivora*) ; but it feeds chiefly on worms, and even on the young of ground-birds, as well as on insects and their grubs, including such pests as the leather-jacket.

The young are born blind, naked and helpless, in a cosy nest of dry grass and leaves, built in an underground chamber in the middle of a mound of earth (Fig. 5) larger than the ordinary mole-hill, which is merely a heap of loose soil. Ingress and egress is had to this chamber by several passages ; but the conventional drawing of a "Mole's fortress," with its two circular galleries and regularly arranged passages, is largely a work of the imagination.


THE MOLE
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XXXIX. THE CAT

EVERY detail of the Cat indicates the beast of prey; while its love of warmth and its dislike of wet suggest that it is a native of hot, dry countries. It does not run down its prey, but prefers to lie in wait and creep cautiously and silently upon it, so as to take it unawares. And since night is the best time to do this most effectively the Cat is fitted for its life as a nocturnal beast of prey.

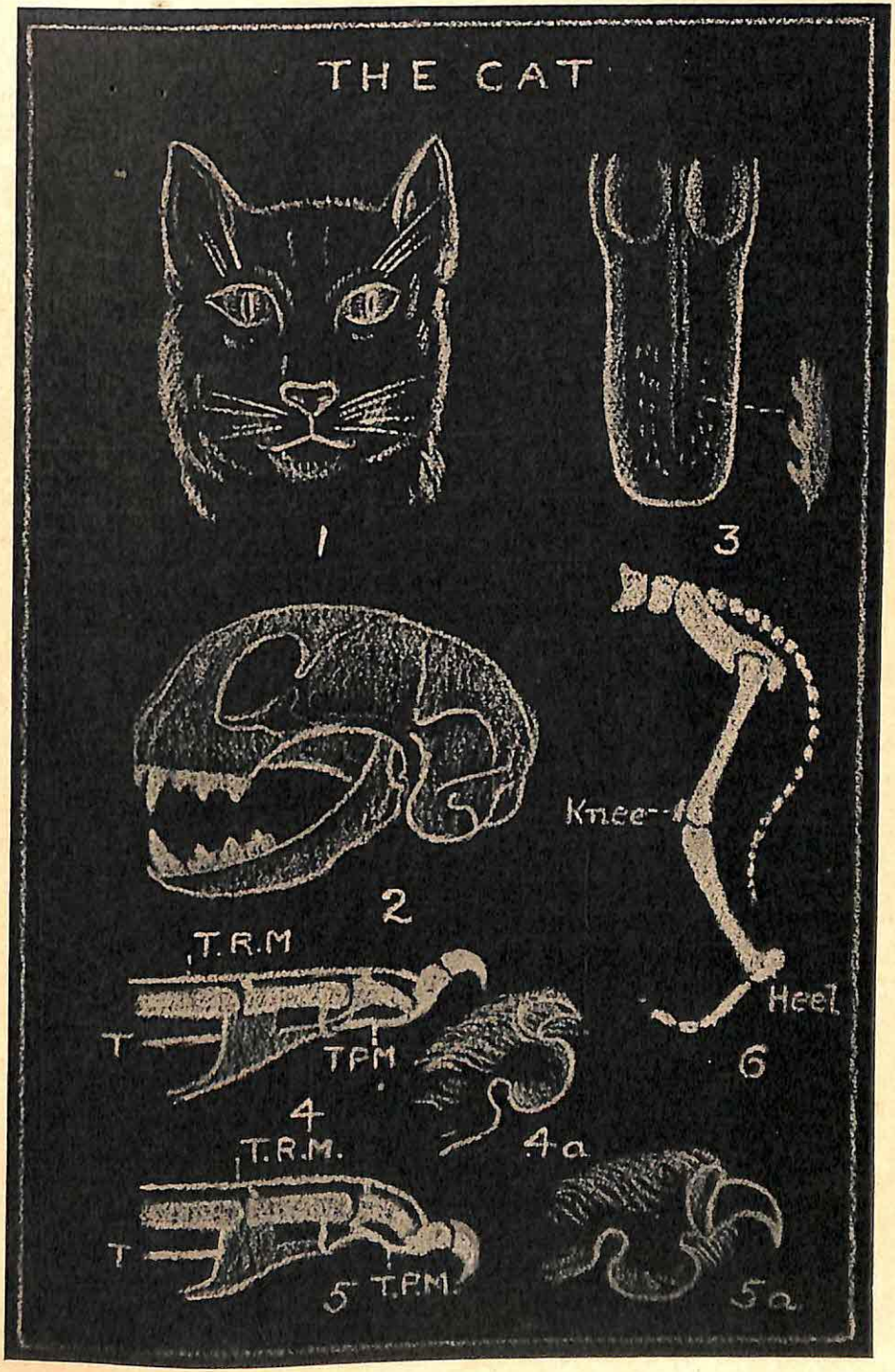
The sense of sight is very keen, so much so that the light of day is too strong and is more or less shut out by the narrowing of the pupils (Fig. 1). It is due to a brilliant lining (*tapetum*) that the eyes of a Cat shine in the dark, this lining being said to be of value by acting almost like a mirror, reflecting the faint light in such a manner as almost to redouble it; but it is difficult to understand how that can be.

The sense of hearing, too, is so keen that the slightest noise is detected, much help being given by the large external ears that can be turned in any direction. But the sense of smell is not nearly so keen as in the Dog, in which connection the difference in the manner of hunting prey must be considered.

Above the eye and at each side of the mouth a number of long hairs (*vibrissæ*) serve almost as so many antennæ: they are delicate feelers of great use in the dark; and, indeed, the whole surface of the Cat's body is far more sensitive in this respect than that of the Dog.

The silent movements of the Cat are largely due to the rubber-like pads on which it walks, the claws being withdrawn (Fig. 4*a*) until they are needed (Fig. 5*a*). [Figs. 4 and 5 show the bones and claw of one toe, and the tendons attached to the muscles that move the claws. T.R.M.=tendon of retractor muscle; T.P.M.=tendon of protractor muscle.] At the moment of leaping on its prey these claws flash forth like so many curved daggers, and bury themselves in the flesh of the victim, which is thereafter torn to pieces (if too large to swallow whole) by the long, pointed corner teeth and the shear-like side teeth (Fig. 2). A bone too large or hard to swallow can be cleared of flesh by the tongue (Fig. 3), the surface of which is covered with backward-pointing horny spines.

The Cat is a toe-walker, the heel being raised above the ground, so that the foot-bones act as a third lever (Fig. 6) enabling the animal to spring long distances. The tail, which is an elongation of the back-bone, acts as a rudder and as a balancing pole both in leaping and falling.


THE CAT
1
3
2
Knee
6
Heel
T.R.M
T
TPM
4
4a
T.R.M.
T
5 T.P.M.
5a

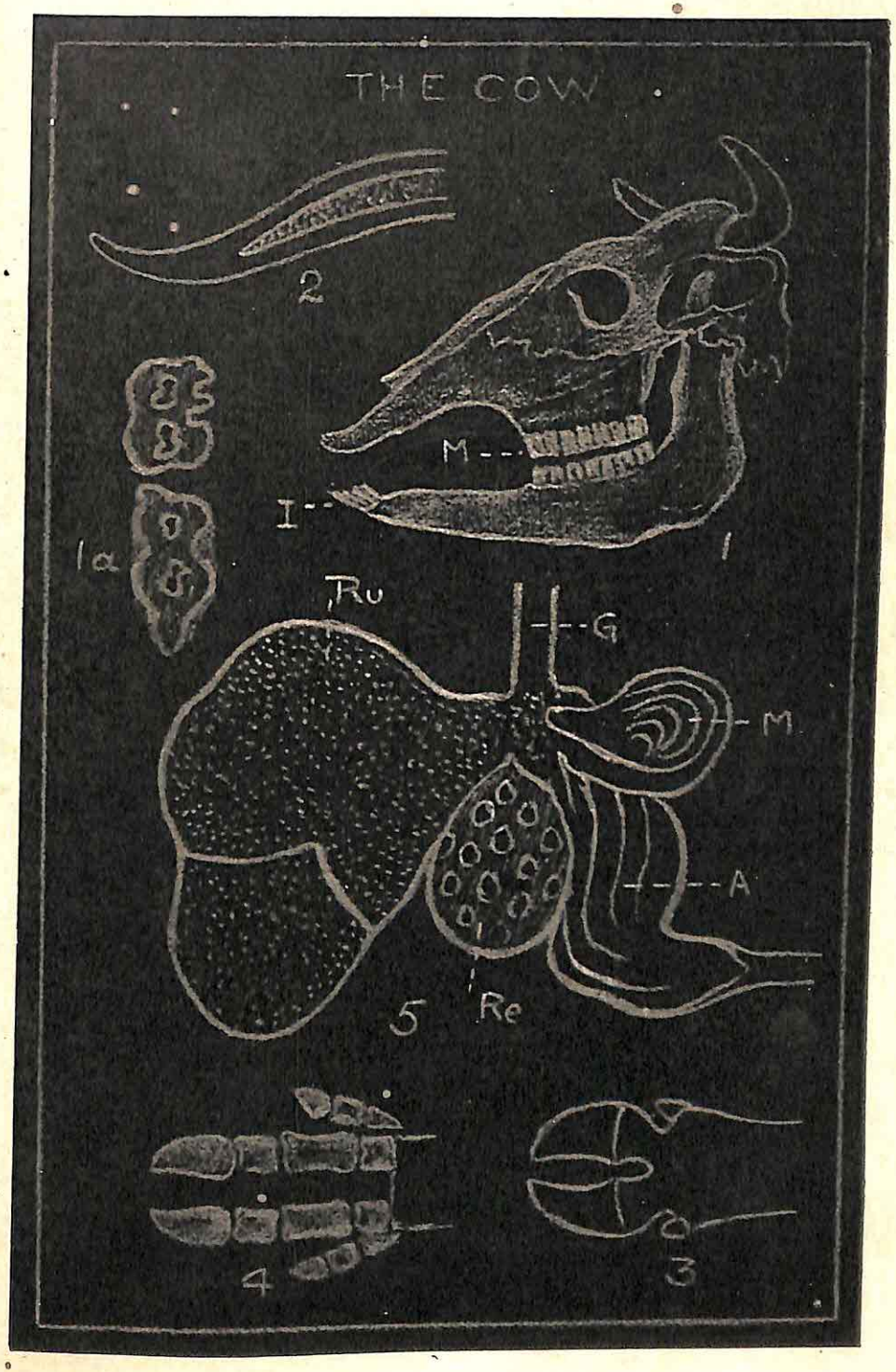
XL. THE COW

THE characteristic features of the Cow, *e.g.*, its big, bulky body, its "split" hoofs, its huge face—which is essentially an apparatus armed with *molars* (Fig. 1, M) for grinding food—indicate clearly that it is a plant-eater (*Herbivore*). Broadly speaking, plant food is not so easily digested as flesh food, nor does it contain so much nourishment: hence the need of thoroughly crushing it before digesting it, and of the very large stomach and intestines which account for the bulky body as contrasted with the slender body of the carnivore, such as the Cat.

There are no pointed tearing teeth, there being a considerable gap between the molars and the cutting teeth (*Incisors*, I), which latter are lacking in the top jaw (Fig. 1*a* shows the grinding surface of two molars with their hard ridges). The food, *e.g.*, grass, is seized with the long mobile tongue, dragged into the mouth, held between the lower incisors and the horny pad in the upper jaw, torn off, and forthwith swallowed. It passes into the large portion of the complex stomach (Fig. 5), called the paunch or rumen (Ru), and this goes on until the animal is satisfied. From the paunch it then passes gradually into the honeycomb bag (Re=*reticulum*) where it is formed into pellets or *cuds*, and when at rest the animal forces these cuds up into the mouth and thoroughly grinds them. This is called *chewing the cud*, or ruminating; and the Cow, a *ruminant*. Again swallowed, the food passes down the gullet (G) into the *manyplies* (M) where it is formed into flattened masses; and thence into the *reed* or *rennet* (A=*abomasum*) where it is digested.

Only ruminants have horns, although not all ruminants are thus armed. The horns are outgrowths of the frontal bones (Fig. 1), enclosed in a horny case (Fig. 2), which is an outgrowth from the skin. Such horns are never shed, as are the solid antlers of the Deer family.

The hoofs, too, belong to the skin, being in reality toenails. In the Cow there are four, two very small ones that do not touch the ground, and two large ones upon which the animal walks (Figs. 3 and 4, the latter showing the toe bones only). Such "split" hoofs are fitted for damp ground beloved of cattle, enabling the animals to walk more easily, and to sink into soft soil much less than would be the case if they had single hoofs like the Horse.


THE COW
2
M
I
1
1a
Ru
G
M
A
5
Re
4
3

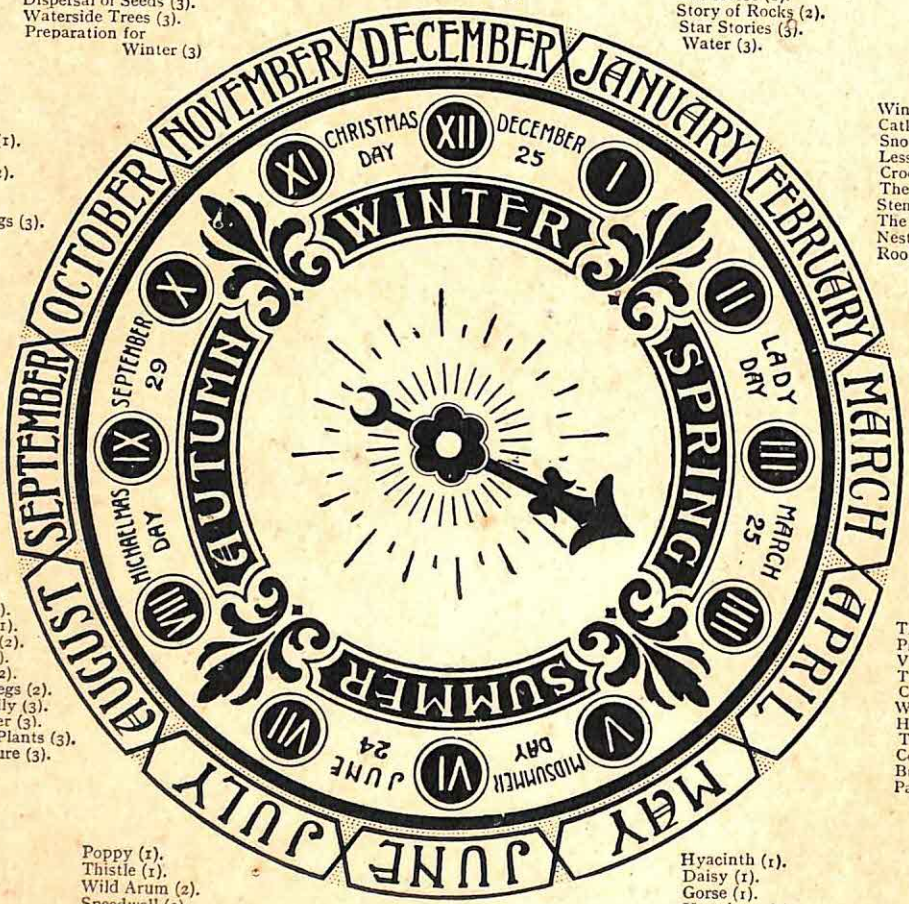
A YEAR'S COURSE IN NATURE STUDY

Ferns and Mosses (1).
The Bat (1).
Fish (1).
Robin and Sparrow (1).
Ivy (2).
The Pig (2).
Dispersal of Seeds (3).
Waterside Trees (3).
Preparation for Winter (3)

The Holly (1).
Mistletoe (1).
Laurel (2).
Frost and Snow (2).
The Shortest Day (3).
City Trees (3).
Our Chalk Hills (3).

Food of Plants (1).
Soil (1).
The Earthworm (1).
The Rabbit (1).
The Horse (2).
Story of Rocks (2).
Star Stories (3).
Water (3).

Partridge (1).
The Oak (1).
The Yew (1).
Fall of the Leaf (1).
Scots Pine (2).
The Mushroom (2).
Heather (3).
Beetles (3).
Seaside Flowerings (3).



Winter Buds (1).
Catkins and Tree Flowers (1).
Snowdrop (1).
Lesser Celandine (1).
Crocus (2).
The Coltsfoot (2).
Stems and their Uses (3).
The Starling (3).
Nests and Eggs (3).
Roots (3).

Fruits and Seed (1).
The Spider (1).
The Oyster (2).
Blackberry (2).
The Ant (2).
Shells of the Shore (2).
Scavengers of the Shore (2).
Among the Rocks (3).
Nature's Poisoners (3).
Clover (3).

The Daffodil (1).
Germination (1).
The Frog (1).
The Mole (1).
Snails and Slugs (1).
Cow and Sheep (2).
Wind (2).
The Potato (2).
The Rook (3).
The March Moth (3).
Defences of Plants (3).
Willow Way (3).

Dragon-fly (1).
Our Cereals (1).
Grasshopper (2).
The Snake (2).
The Earwig (2).
Daddy-long-legs (2).
The Water Lily (3).
The Kingfisher (3).
Flesh-eating Plants (3).
Music of Nature (3).

The Cuckoo (1).
Primrose (1).
Violet (1).
The Wallflower (2).
Clouds and Rain (2).
Windflower (2).
Horse-chestnut (2).
The Skylark (3).
Colour in Nature (3).
Buttercup (3).
Parts of a Flower (3).

Poppy (1).
Thistle (1).
Wild Arum (2).
Speedwell (2).
White Dead Nettle (2).
Foxglove (2).
Wasp (2).
Cockroach (2).
Insect Pests (3).
The Glow-worm (3).
Some Flower Families (3).

Wild Rose (1).
Honeysuckle (1).
Butterfly (1).
The Bee (1).
Silkworm (2).
Beech Tree (2).
The Lime (2).
Aphis and Ladybird (2).
The Owl (2).
The Dandelion (3).
The Gnat (3).
The House-fly (3).
The Grass (3).

Hyacinth (1).
Daisy (1).
Gorse (1).
Hawthorn (1).
The Swallow (2).
The Tulip (2).
The Ash (2).
Flowers and their Visitors (3).
The Lily of the Valley (3).
Scent in Nature (3).
The Cowslip (3).

By the help of this Nature Study Clock you can construct a Syllabus of Nature Lessons for the whole Year. The Lessons will be found in the three Volumes of "The Teacher's Book of Nature Study" (Evans Brothers Ltd., 4/6 each net), marked 1, 2, and 3 respectively. These books have already run into 13 Editions.

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